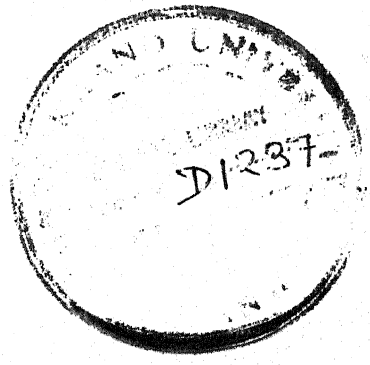
EVALUATION OF RESULTS OF INTERNLOCK NAILING IN THE TREATMENT OF TIBIAL SHAFT FRACTURES

THESIS
FOR
MASTER OF SURGERY
(ORTHOPAEDICS)



BUNDELKHAND UNIVERSITY
JHANSI (U.P.)

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ANIL KUMAR TOMAR

DEPARTMENT OF ORTHOPAEDIC SURGERY,
M.L.B. MEDICAL COLLEGE HOSPITAL,
Jhansi (U.P.)

Certificate

This is to certify that the work entitled **"EVALUATION OF RESULTS OF INTERLOCK NAILING IN THE TREATMENT OF TIBIAL SHAFT FRACTURES"** has been carried out by **Dr. Anil Kumar Tomar** himself in this department.

He has put in the necessary stay in the department as required by the regulation of Bundelkhand University.

28/04/02

(Dr. P.K. DABRAL)
M.S.;
Professor and Head,
Department of Orthopaedic Surgery,
M.L.B. Medical College,
Jhansi (U.P.)

DEPARTMENT OF ORTHOPAEDIC SURGERY,
M.L.B. MEDICAL COLLEGE HOSPITAL,
Jhansi (U.P.)

Certificate

This is to certify that the work entitled **"EVALUATION OF RESULTS OF INTERLOCK NAILING IN THE TREATMENT OF TIBIAL SHAFT FRACTURES"**, which is being submitted as a thesis for M.S. (Orthopaedic Surgery) was carried out by **Dr. Anil Kumar Tomar** under my constant supervision and guidance.

The techniques embodied in this work were undertaken by the candidate himself. The results and observations were checked and verified by me periodically.

(Dr. D.K. GUPTA)
M.S.,
Associate Professor,
Department of Orthopaedic Surgery,
M.L.B. Medical College,
Jhansi (U.P.)

[GUIDE]

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Dedicated this work to my patients whose kind cooperation help me all the time.

20.1.2012

Jhansi

Anil Kumar Tomar

(ANIL KUMAR TOMAR)

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Introduction

INTRODUCTION

With the advent of modern civilization, the life of people has become more comfortable. The distances have shortened and time has expanded. But along with this its inevitable evils have also followed it. Increasing mechanization at home, farm, road or place of work and increasing vehicular traffic has lead to an increase in various type of accidents involving death and disability of an enormous magnitude.

Tibia is the most commonly fractured of all long bones of the body. It is the major weight bearing bone of the leg getting factured by a direct or indirect violence. Road traffic accidents are the commonest cause of these fractures. Which causes a direct trauma thus leading to a both bone fracture at the same level. Along with the fracture there is often soft tissue injury viz. skin and muscle damage. The skin damage is frequently due to crushing caused by the impact or may result from laceration. Thus the frequency of compounding is high. The other mechanism of injury is indirect trauma, which may be a bending force causes a transverse fracture or a rotational strain which cause either an oblique or a spiral fractures. These are usually of simple type unless the spike tears the skin protrudes outside (wound from within).

All fractures of shaft of tibia can not be treated by a simple set of rules. By the very location of tibia is predisposes it to frequent injuries. The medial surface of tibia is sub cutaneous through most of its length. Further more the blood supply of tibia is more precarious than other long bones with their good muscular covers. So it is more prone to infection, delayed union and non-union.

No fracture arouses more controversy regarding the best method of treatment than tibial shaft fractures. For the management of tibial shaft fractures, it has been aptly remarked that one requires the **"Widest Experience, greatest wisdom and nicest clinical judgement"** in order to choose the best of treatment for a particular case.

From the day of Sushruta (1000 BC) a number of methods for treatment of fracture of tibial shaft have been devised. In Ancient India Sushsruta used to treat these fractures by immobilizing the limb in **"Kapata Shayana"**. One of the fourteen types of bandage – "**Bandha**, medicated bandage –"**Kavalika**" or by means of **bark splints** and tying limb with **bamboo strips**. Today the spectrum of treatment ranges from closed reduction and plaster of paris cast immobilization to A.O. and ASIF techniques of rigid internal fixation and highly mechanical and complex external fixatures.

The mechanism of injury in a particular case, the extent of commination, damage of the surrounding soft tissue and the initial displacement are the most important factors that decide the modality of treatment.

However the treatment become more controversial, when high velocity fractures, which result from vehicular accident and are often difficult to manage due to certain inherent peculiarities.

Viz. :-

1. Severe displacement of fracture ends.
2. Comminution of a varying degree.
3. Bone loss.
4. Extensive soft tissue damage.

These fracture are highly unstable, slower to heal and much more prone to shortening, non-union and mal union. The extensive soft tissue disruption and focal vascular compromise that often accompanies such injury predisposes to infection, scarring of muscle and tendons resulting in loss of motion of toe's, foot and ankle and chronic venous insufficiency.

Many alternative methods for treatment of fracture shaft tibia are available on the one hand there is a view that these fractures should primarily be treated with conservative methods i.e. (i) closed reduction and A/K POP cast application (ii) functional cast bracing.

On the other hand there are surgical techniques i.e. fixation by plates, intrafragmentary screw fixation, encirclage, intra medullary nail i.e. simple or with interlocking device, and highly mechanical external fixators i.e. tubular and ring fixator. In the word of **Sir John Charnley** (1961) ***"we have still a long way to go before the best method of treating a fracture of shaft of the tibia can be stated with finality".***

Closed reduction and application of above knee Pop cast (often considered the treatment of choice for low energy fractures) is not satisfactory and is full of inadequate such as loss of reduction, problem of angulation, rotation, swelling deformity, stiffness of joints, neuro vascular impairment are bit to a name of few complications. Which constitute a part of well known "fracture disease".

External fixation .devices have enjoyed long period of enthusiastic use. They afford certain advantages owing to more rigid fixation, early mobilization, protective care for wound without disturbing the fracture alignment of fixation and thus causing least joint stiffness, oedema, muscular atrophy and osteoporosis. The highly mechanized external fixation device have disadvantages of being costly and difficult in assemble specially by an uninitiated surgeon and leads to pintract infection.

Open reduction and internal fixation with plates necessitates soft tissue handling which further jeoparadises the already compromised vascularity of bone and there is increase risk of infections. Application of plate also has local detrimental effect on the vascularity of cortex beneath it. Moreover it acts as a stress shielder thus refractures are not uncommon.

Intra medullary nailing being load sharing device offers a better solution to these fractures, but unstable fractures and fractures of proximal and distal third especially where medullary cavity is too wide standard nailing with Kuntscher nail often fail to prevent telescopy, rotational and angular deformity.

To solve these problems intramedullary nailing with interlocking device is designed.

Interlocked intramedualllary nailing have the following advantages:

1. It provides stable and anatomical reduction.
2. It provides better axial, angulatory and rotational stability.
3. It preserve periosteal and endosteal blood supply as reaming is not done.
4. It can be done by closed method and if done closely than it does not disturb the fracture hematoma, avoids periosteal stripping and this retaining" the vital sole source of blood supply.
5. Small 1.5 –2" Incision with negligible blood loss, short operating time, low risk of infection are additional advantages.
6. Early Joint motions are permitted thus decreasing the chances of joint shiftness and incidence of fracture disease.
7. It provides early weight bearing.
8. Facilitates nursing care in multiple injured patient.
9. Can be done in case of compound fractures.
10. Early healing.

The basic idea of the locking in the inframedullary nail is to synergies the advantage of closed nailing with the added fixation of percutaneously inserted transfixion screws. Interlocked intra medullary nail can be static of dynamic.

But there are certain perquisites of standard interlocked intra medullary nailing such a power drill, flexible reamer and this technique is technically demanding the use of an image intensifier in India and other developing country such facilities are scarce. Which is beyond the affordability of Government setup or majority of private enterprises facing severe financial constant, a simple interlocking (D) nail devised by Dr. K.P. Daga, retain the purpose of interlocking nail.

Thus Daga nailing appears to be a bridge between the less effective K nailing and the more expensive AO technique.

Daga interlock nailing can be done under Xray control and does not need special instruments with this concept in mind the present study of interlocked

intra medullary nailing of tibia without the use of image intensifier has been done for evaluating the efficiency of procedure.

The aim of the present study is to evaluate the result of interlocking intramedullary nail in tibia shaft fractures in the Bundelkhand region.

Review of Literature

REVIEW OF LITERATURE

HISTORICAL BACKGROUND :

Earliest reference to the subject of healing of bone is in Veda (2000 BC). Sanhitas of charak and Sushruta (1000 BC) deal with diagnosis and treatment of various types of fracture and dislocations. Sushruta has described the fracture as **"Kanda Bhang"**. In the treatment of the fractures of lower extremities **"Kapat – Shayana" (Doorbed)** or a fracture board consisting of plank of wood resembling the panel of a door were used. For the fracture of the lower limb often making the patient lie on bed, the injured limb was immobilized with the help of pegs. With two pegs on each side of the joint and one against the planter surface of foot. Immobilization of fracture was also affected by bandages (Bandha) or by means of bark splints or bamboostrips. **Charaka** has mentioned a medicated bandage **"Kavalika"** Which was to applied underneath the splints and tried firmly after setting the fracture.

Apart from these reference, no clear concept of treatment of fractures particularly of lower limbs was available till the middle of 18^{th} century. Heppocrates was probably the first person to study the effect of muscle spasm on fractures which caused shortening and overriding. Hence splinting the limb to over come this problems became popular in the middle of 18^{th} century.

Methysen (1852) a Dutch scientist was the first person to use and popularize plaster of paris technique and also recommended that fractured limbs were to be immobilized with the one joint proximal and one joint distal till complete union occurred.

In 1855 Smith realized the importance of blood flow of bone and the presence of multiple mechanism of regulation of bone blood flow and recommended functional brace for fracture care.

Concept of stimulation of osteosynthesis by the functional use of limb during healing given by H.O. Thomas, (1880) encourage surgeon to use aggressive surgical approach for the treatment of fractures.

Over years a number of methods have evolved for the management of various types of fractures. They can be broadly categorized in to various conservative and operative methods. Conservative methods include closed reduction and plaster and cast bracing, operatic methods includes encirclage, screw fixation, plate and screw fixation, intra medullary nailing, intra medullary nailing with interlocking device i.e. dynamic and static and external fixation i.e. tubular and ring.

Albert Hoff (1904) recommended direct aseptic bone sutures in cases of pronounced displacement of fragments.

Chamionerrer (1910) advised gentle massage and systematic movements in the treatment of fractures and laid down the following principals :-

1. Gradual movement produces best condition for tissue repair, while absolute fixation diminishes the production of reparative process.

2. Earlier the movement is carried out after fractures, more perfect will be the repair.

3. Mobilization brings about a better circulation and absorption of blood and serum with decrease in oedema and pain.

4. Movement not only stimulate repair but also prevent stiffness, muscular atrophy and soft tissue adhesions.

Impressive results have been cited to support both open (Linden 1938 and Valis kakis 1959) and closed methods (Alder 1962, Edward 1965, Sarmiento 1970) of treatment of fracture shaft tibia.

The clinical problem of the tibial fracture is seen by the multiplicity of therapeutic methods which exists (Alder et al 1962). These methods can be divided as follows :-

1. Conservative Methods : Closed reduction followed by plaster immobilization.

2. Open/Closed reduction and internal fixation with or without A.O. or ASIF techniques.

3. Closed reduction followed by immobilization by external fixator.

No method of treatment is applicable to all types of fracture of tibia shaft which are encountered under various circumstances. Various workers have reported the results of different methods of treatment.

Conservative Treatment of Fracture Tibia :

Oskar Linden (1938) observed in a study of 52 cases treated by conventional methods. The average healing time was 22.3 weeks. The average shortening was 1 to 2cm., with 5 to 10° of valgus deformity in 38.4 percent and varus deformity in 25 cases.

Griffth (1942) analyzed 249 cases of fractures of both bones in the patient treated by closed method of reduction with above knee plaster of paris cast. The mean time of union was 16.5 weeks and eight cases had non-union.

Robert Funstein (1945) reviewed 14.9 cases of fracture of both bone leg and found average healing time to be 11.2 weeks for clinical union and 30.4 Weeks for radiological union. Types of fractures made practically no difference in the rate of healing.

Carpenter (1952) and Jackson (1959) concluded that 95% of tibial shaft fractures, whether simple, comminuted or compound can be adequately managed by closed reduction with the advantage that such conservative means will avoid serious complications and will enable the fracture to heal in a shorter period that a similar fracture treated. Their conclusion is that the initial haematoma around a fracture contains osteogenic properties. Which help in healing of fractures. If this haematoma is exposed to external environment by open reduction, not only the union of fracture is delayed but also chances of infection increases.

Nicoll (1964) in a survey of 705 cases, of which 674 cases of tibial shaft fractures were treated conservatively. He observed the average time of union of fracture was 16 weeks (12-20 weeks) incidence of delayed and non-union in infected cases was 60%. 25% cases had foot and ankle stiffness. He also stated that internal fixation can be justified on grounds that it reduced the incidence of functionally significant deformity and joint stiffness. It significantly lowered the incidence of delayed and non-union.

Weissman and Herald (1966) treated tibial shaft fracture without internal fixation in 150 cases and found that the average time of union was four months and seventeen days along with average time of hospitalization of seven days. Temporary limitation of movement at ankle and knee was observed in most patient during first few months after plaster was removed. Shortening of leg amounting to 3", 2",1 ½", 1" respectively was observed, four cases and one case had various angulation of 30 degree. Seven patients had pain over the fracture site for more than seven months.

Sarmiento (1970) treated 135 of fractures shaft tibia by a functional below knee brace and stated that the patient walked with full weight bearing after 4 weeks of injury average healing time was 14.1 weeks in both bone fracture and 16.8 weeks when fibula was intact. Average amount of shortening observed was 6.4mm, no rotational deformity was recognized at follow up but the ultimate degree of rotation of distal fragment was net measured accurately. Several minor pressure source were encountered in the politeal fossa.

Treatment of Tibial Fracture by Walking Cast :

The technique of walking cast was first developed by Krause (1891) and later by Dollinger and Budapest (1893) . They used to apply the unpadded plaster to treat fracture of leg so that weight might be transmitted from tuberosity of tibia to bottom of plaster.

Egger (1949) demonstrated the effect of contact compression factor on the osteofeneis in surgical fractures he described two forces acting at fracture sets, the internal force exerted by the mass of the muscle especially in the

voluntary contraction and external contact compression exerted by gravity and weight bearing. He concluded that :-

1. Presence of contact compression fracture stimulate the osteogenesis.
2. Excessive compression fails to stimulate osteogenesis.

Dehne (1961) treated fractured tibia by immobilization in a near skintight cast with knee held in full extension and with immediate weight bearing. The average time of healing and return to work for all 207 patients was five months. In 86% of patients the time for healing and mobilization was between four and six months. In remaining 14% cases it varied from two to four months.

Gamble et al (1972) treated 100 fractures of tibia by easily weight bearing in long leg cast and evaluated the result close to Brown and Urban (1974). Brown concluded that the closed reduction and early weight bearing in long leg cast often concedes minor complication. In favour of a predictable high union rate with no major complications and can be used for all types of tibial shaft fractures.

The advantage of ambulation were explained as the alternating contraction and relaxation of muscles of leg with improve circulation in the extremity and fracture site. Vanous return was enhanced, oedema was minimal and muscle tone maintained. All of which facilitated the mobilization of the knee and ankle. When the cast was removed.

A below knee cast moulded in a manner resembling that of the patellar tendon bearing prosthesis stabilizes the proximal fragment of tibial fractures. Weight bearing pressure are transmitted from the ground to the proximal end of tibia virtually by passing the fracture site and suspending the fracture bone. The triangular moulding of the upper portion of the cast – against the inserted pyramid of proximal fragments prevents rotation of over riding of fragment. The indentation over petellar tendon and femoral condyles appear to enhance the rotational stability.

This method of closed reduction and early weight bearing by either above knee or below knee last is suitable for stable fractures or transverse fractures. Fractures that are oblique or comminuted and are unstable if suspected to above treatment may angulate or shorten unless some additional fixation is used.

Trivedi and Patel (1978) used the method of insertein of steinmen pins and incorporated there in a below knee total contact cast in 80 cases of fracture tibia and compared the result with above knee costs. The result showed that the average duration of plaster immobilization was about same in both series to 4.2 months in below knee method and 4.5 months in above knee method. The occurrence of delayed union and failure sate were strictly lower in former method. The only complication was pintract infection and loosening of pin. Early ambulation with full range of movements at knee minimized the quadrips wasting.

Treatment of Tibial Fracture by plats and screw :

Tibial shaft fractures treated by plata and screws have been used by various worker. (Egger, 1945, Whetel, 1953, Raynold, 1954, and Burwell, 1971).

Wade and Campbell (1958) reported discouraging results with the use of plates as compared to other term of surgery. According to them endosteum appears to assume the sole responsibility for binding the fracture site, but fixed distraction and excess of foreign material made the use of plate hazardous.

Edward (1965) stated that tibial fractures treated by open reduction and plate fixation both in closed and open fracture resulted in high rate of infection.

Maller et al (1965) treated tibial shaft fracture by compression plates. He reported encouraging result with dynamic compression plate and reported 93% results in good whereas only 6% complication rate was found in closed gp treated fracture of tibia.

Berkin and marshal (1972) used three sided plate fixation for fracture of tibia two plate, which were slotted fenestrated and gutter shaped were placed such that its linear margin would be in contact of bone in two side and an Eggar's

slotted plate placed along the third side. This assembly did not result in to angulation. 92 tibial fracture were treated with above method. The overall results were very good in 72 cases, 11 were good and nine were satisfactory delayed union occurred in 11 patients.

Linder and Larsen (1979) in a randomized trial of 100 transplaced fractures treated conservatively or by 40 pleating found that complication in the 4.0 group were more common. Their stay in the hospital was more delayed union more frequent but A,O group healed faster with average time of 12 weeks as compared to more conservative group, where healing time was 17 weeks. Whereas open fractures healed faster when treated conservatively.

Screw fixation was sometime favoured for spiral or oblique fracture but while, Reddy and Kerly (1953) Mazet and Mackan (1954) and Charnley (1961) claimed that this method is uncertain. Since number of fractures redisplaced despite plaster unimoblization and there were more chances of non-union.

Treatment of Tibial Fracture by External Fixator :

Although open method offered exact opposition of fragments yet they bring potential danger of infections and delayed or non-union. External fixation refers to a method of immobilization of fracture with two or more pin 3 attached to a rigid external metal frame or incorporated in plaster.

The first external fixator for treatment of fractures was described by Malgaigne (1851), Parkhill (1897) describe the use of two half pins above and two half pins below the fracture in long bone externally joined by an indegenous clamp for fracture reduction and immobilization.

Raoul Hoffmann (1938) developed a four plaster double frame external fixation device. He presented a series of articles describing her method of external fixation from 1938 to 1954.

Karl strom and olerud (1975) treated 28 severe, open tibial fractures with stable external frame fixation by the vidal adrey double frame method. The

average time of limb kept in frame was 4.9 months and the of P.T.B. cast was used. The mean time until full weight bearing without external support was 7.9 months.

Edward (1979) reported the study of 44 open tibial fractures 73% of cases had bone loss or major communication after initial debridement, double frame Hoffmann apparatus was applied and fracture reduced. Initial union was evidence at 4 months complete at 7 months 35% cases developed pintract infection. Which cleared off after removal of pins.

Clampsey et al (1979) treated open tibial fractures, 56 with cast immobilization, 35 with internal fixation and seven with external fixation. Average time of healing was 19.5, 19 and 28 weeks respectively. Deep infection more in cases with internal fixation. (11%) than in cases treated with cast immobilization.

The favourable effect of pressure at fracture site was first described by Sir Huge owen. Thomas of Liverpool and later by Sir, Robert Jones, who used in expose and hammer the fracture site in cases of non union to achieve union.

Evaluation of Intramedullary nailing and interlocking device :

Intramedullary nailing 5 one of the greatest advances in the field of orthopaedics. Although concept of intra medullary nailing is old, most of the development has occurred in last 5 decade.

The term nail was adopted by Lea Johre (1902) and pointed out that the nail must be long enough and should fit well in the cavity.

Glucks (1903) described the use of metal nail and they were anchored on to the base by Ivory pages proximally and distally this was infact a type of locking nail. In (1907) he laid down the principles of intra medullary nailing.

Until (1916) experiments were carried out with various materials as splintage for marrow. They include Ivory, horns, fish bone, Cadaver bone, silver steel etc.

Hey Groves (1918) used metal nail to treat femoral pseudoarthrosis.

In (1937) Rush brothers introduced thin metal having advantage of easy insertion of filling of marrow cavity with one or more metal wire was introduced by Lambotte (1937).

Kuntscher (1940) used intramedullary nailing successfully and popularized cloverleaf pattern nail for long bone fractures.

Hansen and street (1945) used diamond shaped nail and found that rotational stability was better.

Schneider (1951) designed a nail which incorporated both double ended and self-breading feature. The nail was fluted with a square cross section.

Lottes (1952) introduced 'V' shaped nail for intra medullary fixation and reported full weight bearing at the end of 5 months in 74% of nailed cases, 15% of plating, 6% of those treated by conservative methods.

Lottes (1952) evaluated the results of 176 fractures of the tibial shaft treated by nailing, plating and plaster immobilization. The average healing time was six months, 11.8 months and 8.4 months respectively. Incidence of non union was 23.7% with plating, 10% with conservative treatment and none with nailing. As regards the deformity, there was varus or valgus angulation of three degree or more in 19.6% cases of conservative treatment, 5.7% in closed nailing and 4.3% in plate fixation.

In (1967) image intensifier became generally available and this greatly facilitated further development of intra medullary nailing.

Kuntscher continually tried to make improvement to his nail to broaden it's indications.

In 1968 Kuntscher published his technique for stabilizing comminuted fractures by inserting nails of different thickness and length over one another.

Zuckman and Maurer (1969) reported 36 cases of two level fractures of tibia treated by blind nailing of which 17 patients had closed fractures. Primary bone union in good position was obtained in 15 cases and asepetic union was found in 0.2%. No case had malunion, union with sepsis or septic non union. They concluded that both the fractures upper and lower had the same potential for union. In these cases walking was started with full weight bearing in an average time of three to four months and it decreases the rate of non union and infection as compared with other type of fixation devices.

Conventional intramedullary nailing provides poor fixation in upper and lower third fractures and in other unstable fractures. To overcome this problem, transfixation screw were introduced. It not only extended its indications but stabilization was also increased.

All unstable fracture of tibial shaft can be fixed by interlocking nail. The basic idea of the locking nail is to combine the advantages of closed nailing with added fixation of porcutaneously inserted transfixation screws. Interlocked intra medullary nailing can be static or dynamic.

These screws are introduced through predrilled holes of the proximal and / or distal ends of the nail. Insertein of screw at both ends of nails result in fixation of the major proximal and distal fragments. The prevents sliding of these fragments along the nail and is termed "Static nailing".

Alternatively the screw can be inserted in the only one end of nail, fixing only one of the major fragments. The other fragments achieves purchase through endosteal contact with the nail. In this situation the unfixed fragment is able to slide axially, along the nail, permitting impaction at the fracture site or non-union. This type of fixation is termed "Dynamic locking".

Static fixation prevents axial sliding of both major fragments and can potentially interfere with later stage of healing and remodeling. To resolve this problem screw from the stable fragment can be removed within 8-12 weeks of initial static nailing Gross has termed this step "Dynamization".

The indication of static nailing are fractures that are comminuted or have bone loss. These fracture would otherwise shorten and rotate around a standard Kuntscher nail, producing telescopy and protrusion of implant. By inserting locking screw at both end of nail, such fracture can be held to normal length until sufficient callus has formed to prevent shortening. When the screw at either and can be removed permitting axial loading of newly formed callus to promote better remodeling. The decision of which screw or screws should be removed is dependent upon the level and pattern of fracture. The one that are more valuable in preventing rotations and angulation are retained that is the screw in the unstable smaller fragments.

In 1968 Herzog described a technique in which a Kuntscher nail. Which have been provided with various holes were percutaneously locked with K wire.

In 1968 Kuntscher described the application of nail. Which was attached to the femoral shaft with screw proximally and distally. He called this "Detenser".

In 1970 Klemm and Schellmeen developed the Kuntscher detenser nail and developed instrumentation for insertion extraction and locking of nail. They also advocated two screw instead of one for distal locking and proximal screw at an angle instead of transverse.

In the early 1970s Arsen Groose led to the development of another version of locking Kuntscher nail. The Gross kemf nail similar in design to the A,O nail.

Like the A,O nail. The Grosse Kemf nail has a cylindrical proximal section with an internally threaded segment that permit attachment of both drivers and target device.

In 1977 Groose and Kerif improved the nail and designed a distal locking device. Which could be attached to c-arm of image intensifier. This increased the use of locking as a routine procedure.

Sharma et. al. (1978) treated 45 cases of fracture shaft tibia by intramedullary 'V nailing'. Clinical union was evident by 10-15 weeks.

Complications developed like deep wound infection in 17.2% and bending of nail in 7.4%. patient was allowed to walk with the help of crutches after removal of stitches and was allowed to walk with weight bearing after 6 weeks. The hospital stay was from 11-20 days.

Groose, kempf (1982) used interlocking tibial nail which have holes through their proximal and distal ends and are used for fractures of proximal or distal third of tibia, segmental fractures and fractures with significant comminution.

Johnson et. al. (1984) in a retrospective study reviewed result of treatment of comminuted tibial shaft fracture by circlage wires and intramedullary nail or locked intramedullary nails. The result of interlocking nail were found to be superior than the other technique.

In 1984, Veith et. al. also reported a series of 64 patients treated by interlocking intramedullary nailing and found satisfactory results.

Kemf et al (1985) showed that the locked intramedullary nailing by providing greater stability extends the indication for intramedullary nailing to severely comminuted, oblique and spiral fractures as well as to fracture complicated by loss of bone and fractures in the proximal and distal ends of tibial shaft.

Lawrence and Kenneth (1986) treated 112 fractures of the tibia by manipulation reduction, reaming of medullary canal and fixation of fragments with an intramedullary nail either ASIF/AO or interlocking nail. Follow up evaluation was performed in 100 fractures. The average time of union of fracture was 19 week. Two patient had delayed union. Deep sepsis developed in 7% and superficial in 2%.

In 1989 Reudi, Barandun et.al. studied the new A.O. universal tibial nail with interlocking possibility. The nail has been studied in 17 patients with overall good results.

In 1990 Court Brown et al studied the Groose Kemf intralocking nail in management of 125 closed and type I open tibial fractures. They reported mean time of union 16.7 week. Infection rate 1.6%. They suggested the closed nailing with interlocking as an excellent method by treating closed and type I open tibial fractures.

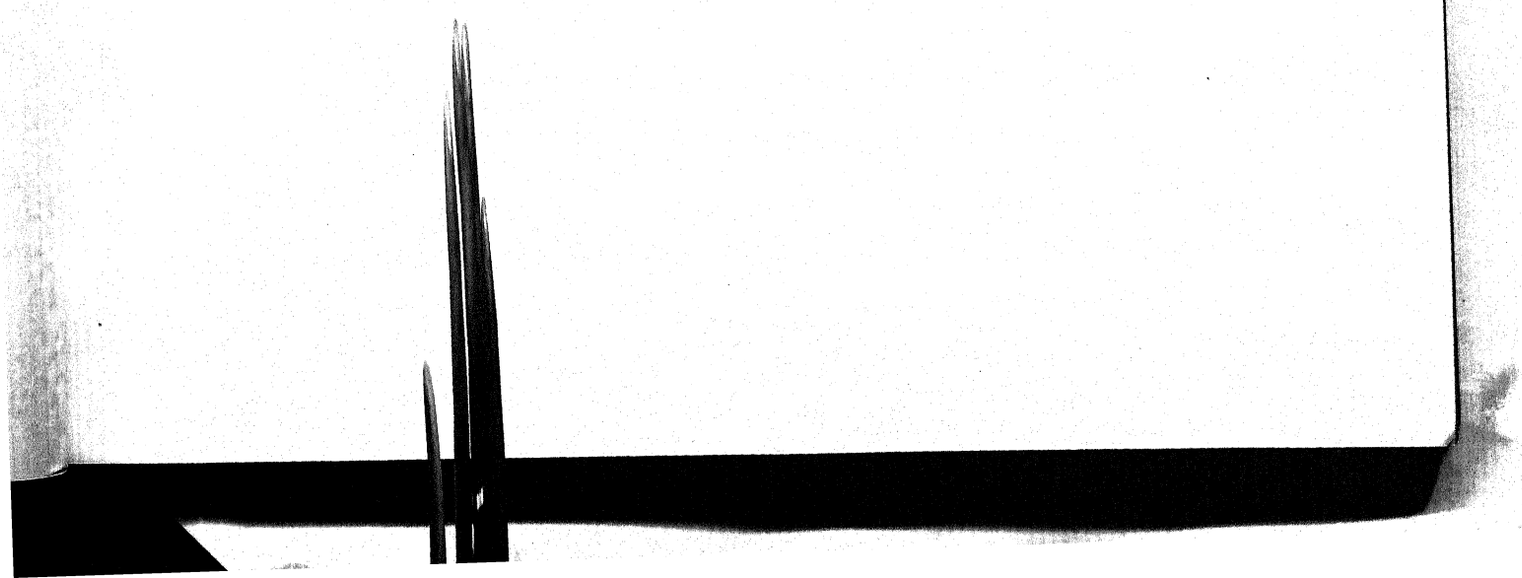
A Paige whittle et al (1992) studied the 50 cases of compound tibia fractures treated by interlocking nail without reaming 68% of these fracture were gr. III compound. 96% of all cases unitein seven months, 8% got infection all were gr III. 10% got breakage of locking screw. But this did not result in loss of reduction. They recommended locking nail for compound fracture of tibia as an excellent method.

Paul Torenetter III et al (1994) compared the result of external fixation and non-reamed locking nail in Gr. III B tibial fractures in 21 patients. They found nailed fractures was easier to manage and rate of infection were not significantly different.

Jeiarns Yves Dela Caffiniere et al (1994) used a new method of locked intramedullary flexible osteosynthesis in 97 tibial fractures and found LIFO device can provided reliable fixation for unstable fractures.

In 1994 Dr. K.P. Daga devised a simple interlocking 'D' nail. It is stronger, providing better fixation with interlocking facility, relatively cheap, does not need special instrument and it can be done under x-ray control. They find good result with 'D' interlocking nail were very encouraging and convincing.

Material and Methods



MATERIAL AND METHODS

The proposed study "Evaluation of results of interlock intramedullary nailing in the treatment of tibial shaft fractures was conducted in the department of orthopaedics M.L.B. Medical College and associated hospital Jhansi (U.P.).

All the patients with fracture of tibial shaft attending the orthopedics department both emergency or routine irrespective of sex were included in the study. However the children below the age of 12 and fractures of proximal one third were excluded.

Criteria For Selection Of Cases :

1. Unstable fractures.
2. Segmental # of tibial shaft.
3. Grade I, II, III A compound fracture of tibia.
4. Displaced comminuted or uncomminuted fractures of tibial shaft, where closed reduction failed or lost.
5. Poly trauma patient.

MANAGEMENT OF FRACTURE

As soon as patient attended the hospital first aid was given in the form splintage and nonsteroidal anti-inflammatory analgesics. In open fractures debridament and antibiotics was given in addition to above.

Cases were subjected for detailed examination under following heads :-

1. Detailed history with special attention to mode of injury, duration of injury, associated injuries and occupation of patients.
2. General and systemic examination of patients.
3. Local examination of affected limb with special attention to condition of skin, soft tissue and neuro vascular status.

4. Xray of leg with knee and ankle joints in antero posterior and lateral view.

5. Patient was investigated regarding suitability and fitness for anesthesia and surgery.

6. The soft tissue damage and severity of compounding is assessed based on criteria as proposed by Gustilo et al (1984).

Type I – Wound i.e. one cm. or less with minimal or no contamination caused by low velocity trauma such as protrusion of bone fragments from within.

Type II – Wound is more than 1 cm in size without extensive soft tissue damage, skin flap or avulsion.

Type III A - Open fracture with extensive soft tissue laceration or flaps but adequate soft tissue coverage of bone, resulting from high-energy trauma.

Type III B – Open fracture with extensive soft tissue loss, with periosteal stripping and bone exposure. These are severely contaminated.

Type III C – Fracture with neuro vascular impairment that requires repair regardless of soft tissue wound.

Pre Operative Assessment :

Cases were assessed by clinical radiological and laboratory investigations. Preoperatively size of nail were determined. Length of nail were taken by measuring the distance from medial malleolus to tibial tuberosity on unaffected side. A nail 1.3 cm shorter was selected for fixation. Diameter of nail were determined by Kuntscher nail gauze. Which had calibrated hole's ranging from six mm diameter with an increment of one mm each up to 14 mm was placed by the side of limb. In such a way to give the same magnification of medullary canal as that of celebrated holes were matched with the narrowest diameter of medullary canal on roentgenogram to give require width of nail.

The data so collected was in the Performa as below :-

Case No :

MRD No :

Name of Patient : Address :

Age/ Sex :

Brief History :

Date of admission :

Date of injury :

Mode of injury :

Associated injury if any :

Fracture :

Side : Right / Left / both

Site : Proximal / middle / distal

Bone involved : Tibia / Tibia and fibula both

Nature : Simple / compound

Communication : present / not present

Fracture line : Transverse / short oblique / long oblique segmental / spiral

Time interval between injury and first and treatment received :-

IMPLANTS AND INSTRUMENTS

Apart from he general set of instruments following are specially required :

1. 'D' interlocking tibial nail.
2. Cortical screws 4.5 mm.
3. Curved bone awl.
4. Master 'D' nail.
5. Drill bit 3.2 mm diameter.
6. Tape for 4.5 mm cortical screw.
7. Tape sleeve 4.5 mm diameter.
8. Depth gauge for 4.5 mm screw.
9. Hexagonal screw driver for 4.5 mm certical screw.
10. Universal K nail extractor.
11. Mallet.
12. Electric torch.
13. K wire.
14. X- ray machine (image intensifier desirable).
15. Two hypodermic needle of 18 gauge.

OPERATIVE TECHNIQUES :

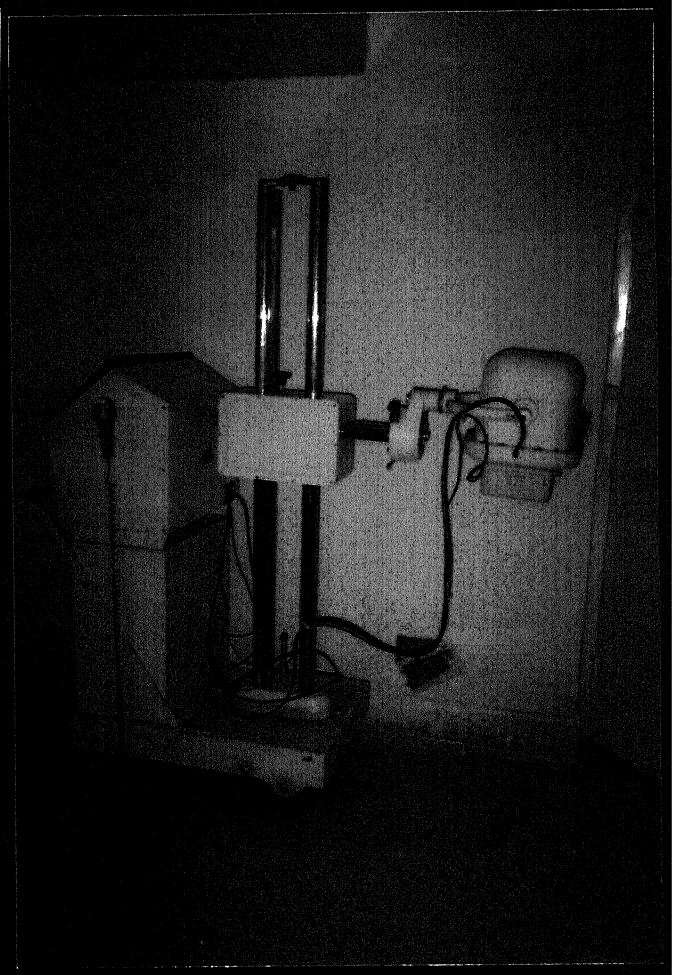
- ***Anesthesia :*** Spinal, Epidural or General anaesthesia as suitability of the patient.

- ***Positioning of patient :*** The patient is supine with knee flexed.

- ***Operative steps :*** Part is thoroughly prepared, painted and draped. The 1.5 – 2 inch curvilinear incision is given on antero medial aspect of proximal end of tibia. Ligamenthum patella is retracted laterally. A window is created at another cortex of tibia slightly proximal and slightly offset medially to the tibial tuberosity sufficiently below the intercondylar area to avoid damage to the joint and ligament patellae.

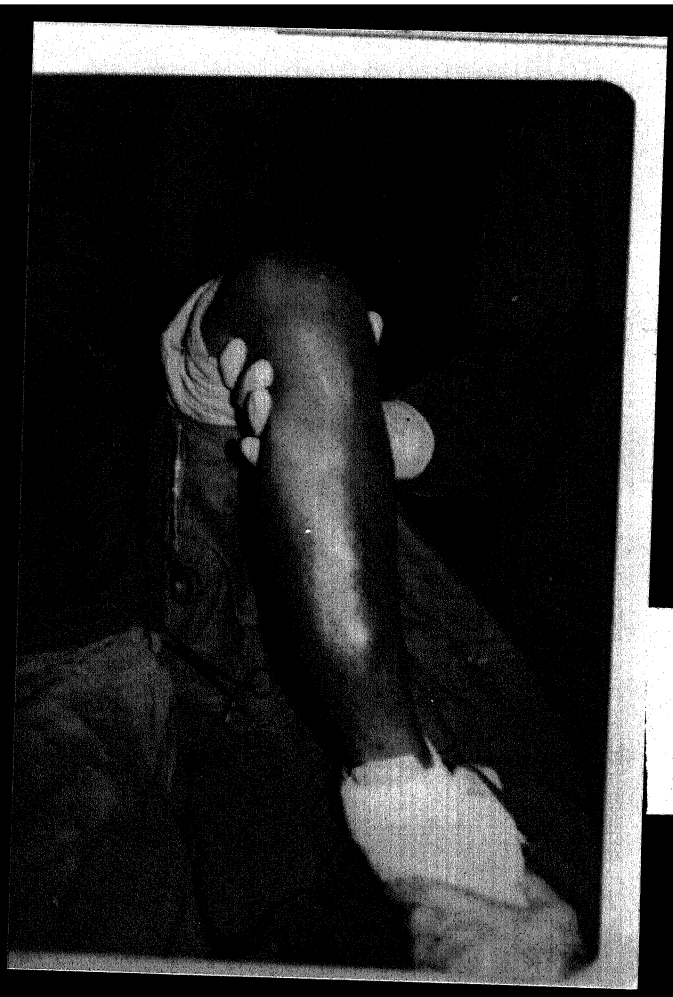
This window is created by osteotome at entry site from 3 side i.e. medially, laterally and inferiority and with the help of blunt osteotome the flap is raised

Photograph -1 (Above)
Shows X-ray AP & lateral a gaze placed along side helps determine the diameter of the nail preoperatively.



Photograph -2 (Above)
Portable mobile X-ray machine very useful during interlocking.

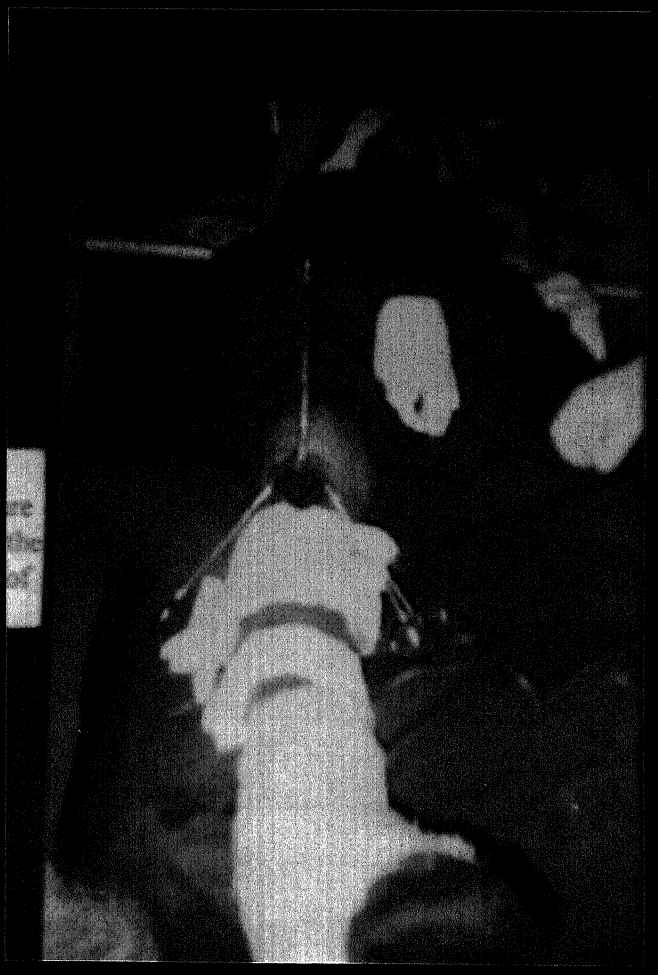
Photograph -3 (Above)
Shows the basic instruments & implants required for the procedure.



Photograph - 4 (Left)
Patient is placed supine on the table with knee flexed. The limb is drapped free keeping the knee & leg exposed upto the ankle.

Photograph - 5 (Right)
Shows the incision placed for the insertion of the nail.

Photograph -6 (Left)
Shows a hole communicating with the medullary cavity being made using a bone awl.



Photograph-7 (Right)
Shows the Completion of above procedure. This hole shall same as portal of entry for the nail. The bone awl is in the shaft of axis of tibia.

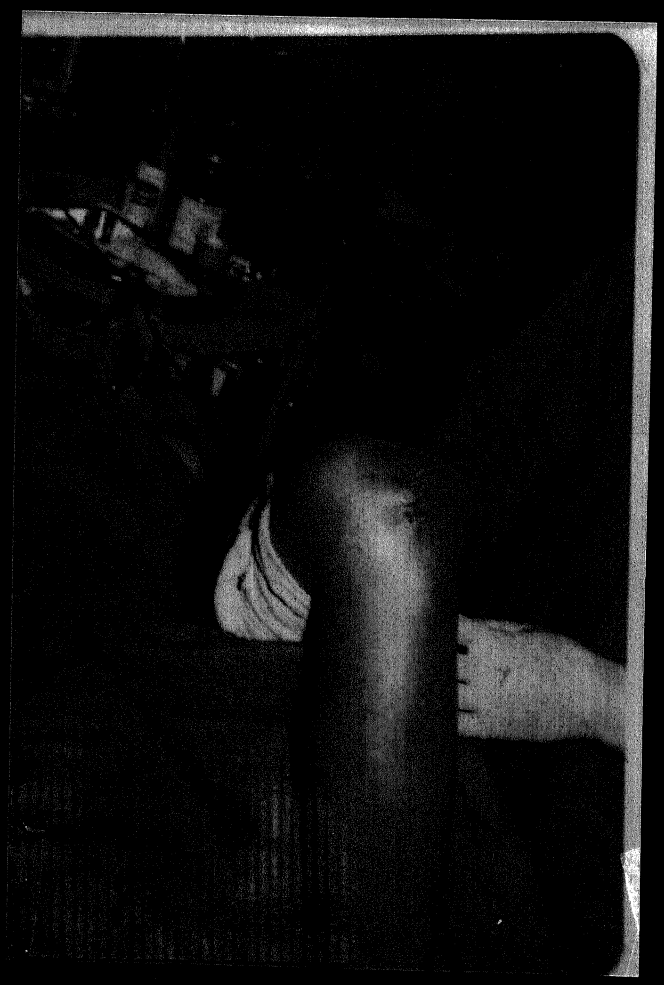
Photograph -8 (Above)
Shows the insertion of the nail, a gaze has been used to prevent crushing of the skin during hammering. The assistent mean while maintains the reduction as the nail crosses the fracture site.

Photograph -9 (Above)
The above procedure a nearing completion, all but the last few centimetre of the nail has been inserted.

Photograph -10 (Above)
With the nail in place a master nail is used to approximately localized the distal inter locking hole & hypodermic needles in two planes are inserted followed by radiological confirmation.

Photograph -11 (Above)
A hole is being drilled in the cortex overlying the hole.

Photograph -12 (Above)
The hole is tapped & after measuring the depth of distal interlocking screw of appropriate size is screwed.



Photograph -13 (Right)
The skin incision over entry portal is closed with nonabsorbable sutures.

upwards and inwards. The 'D' shaped platform lies under this flap at completion of operation so that it tries to prevent proximal irrigation of nail. After creating the window curved bone awl was used for opening the medullary canal and push it as far as possible in to the medullary canal until the handle is in line with shaft axis. Then a thin nail is passed to judge the direction of medullary cavity of tibia for some distance and extracted out. During this procedure skin is protected by skin protector. Reduction of fracture was done by conventional methods. If fails then by limited exposure technique. A inter locking nail of pre calculated size has introduced as pushed into the marrow by gentle blow of mallet. Maintain the reduction till the nail is being advanced is distal fragment. Stability of reduction was judged by rigidity, immobility etc. This is confirmed by Xray. The direction of eye of nail is controlled by artery forcep holding it stable. Upper end of 'D' nail is buried in the window. Upper border should be about against the upper border of window.

The rough judgement of the position of distal interlocking hole of intra medullary 'D' nail is done by putting another 'D' nail of the same length or by master 'D' nail on the medial surface of the leg. And two hypodermic needle are put medical and lateral to the anticipated site of distal interlocking hole of nail in situ. Xray is taken to confirm the position of interlocking hole.

After confirmation a small nick is made over the skin. After exposure of bone a drill hole is made with 3.2 mm drill but in the near cortex of tibia and K wire is introduced through the hole so made in near cortex to locate the hole in the nail and drill is advanced to drill the far cortex.

After tapping, a cortical screw (4.5 mm) of proper length is measured and fixed through the hole. If the fracture is unstable proximal interlocking is also done under direct vision. The final position of nail is confirmed by X-rays. Then the wound closed in layer over suction drainage. Sterile dressing done and a crepe bandage applied from toes to above the knee.

Post Operative Management :

No external splintage is given following the operation. Xray of leg (full length) with knee and ankle joint – AP and lateral view is taken. A care full watch is kept to detect and treat the possible post operative complications like Compartmental syndrome, superficial or deep infections, physiotherapy of all the joint is encouraged the same evening or next day as far pain tolerance of patient.

Stitches are removed after the after the 12^{th} day of operation and note of limb length discrepancy if any taken. Further partial weight bearing status of patient is determined by the fracture pattern and associated injury if any. Partial weight bearing started as soon as the patient tolerated it. Full weight bearing in all cases was started only after clinical and radiological union.

Follow Up : Patients were assessed radiological every month and a through clinical examination was done to note the :

1. Range of knee and ankle movement.
2. Pain
3. Varus or valgus angulation.
4. Limb length discrepancy.
5. Any associated complaints.

Fracture were called united when traversing trabeculae at fracture site had appeared and there was no tenderness and no pain at fracture site on weight bearing.

Criteria for Results :

Results are assessed on the criteria proposed by Reudi and Allgower (1976) and are labelled as.

Very Good : Complete recovery of anatomy and function.

Good: Minor problems only such as sensitivity to weather, tendency to swelling after exercises and loss of movement of knee and ankle joints of $5\text{-}15^0$, superficial infections.

Moderate : Total loss of movements of $20\text{-}30^0$ especially at the ankle associated with some swelling and pain which continued after removal of implaints.

Poor : Disability persists because of pain and stiffness.

Observations

OBSERVATIONS

The observations of the present series are based on the study of twenty patients of unstable tibial shaft fracture treated by interlocking nail, attending out patient or emergency department of M.L.B. Medical college Hospital, Jhansi (U.P.) between May 98 to December 1999.

Age :- Patients of all ages except children below the age of 12 year were the subject of this study. Majority (90%) of the patients were young adults between 19-60 years of age. One patient (5%) was the old man about 65 years of age and the other was a young boy about 15 years of age as depicted in table No. 1.

Table No. 1 Showing Age Distributions.

Age group	No. of Cases	Percentage
<12	Nil	-
12-18 year	1	5
19-40 years	12	60
41-60 years	6	30
>60 years	1	5
Total	20	100

Sex :- All the patients irrespective of sex were subjects of this study. However majority (85%) of our patients were males, only 3 cases (15%) were females as shown below in table no. 2.

Table No. 2 Showing Sex – Incidence

Sex	No. of Cases	%
Male	17	85
Female	3	15
Total	20	100

Occupations Of Patients :

In the present series most of the patients were labourer and farmer 5 each (25%) out of 20 cases followed by (15%) 5 cases each of service man (Clerks),

businessman House wife and one case (5%) was an student as shown below in table number III.

Table No. III showing occupation of patients

Occupations	No. of Cases	%
Labourer	5	25
Farmer	5	25
Businessman	3	15
Serviceman	3	15
House wife	3	15
Student	1	5
Total	20	100

Mode Of Injury :-

In our study incidentally or coincidentally in majority of the cases. Injury was caused by road traffic accident followed by 3 cases (15%) due to fall from height and 2 cases (10%) due to fall of heavy object over limb.

Table No. IV Showing Mode of Injury

SN	Mode of Injury	No. of Cases	%
1.	Road traffic accident	15	75
2.	Fall from height	3	15
3.	Fall of heavy object over limb	2	10
	Total	20	100

Side Involved : Out of 20 cases of present study right tibia has involved in 65% of cases, while left in 7 (35%) cases as depicted in table no. V.

Table No. V. Showing Side Involved

Side Involved	No. of Cases	Percentage
Right	13	65
Left	7	35
Total	20	100

Condition Of Fibula :- Among the twenty cases of present study 19 patient had associated fracture of fibula of the same side while only one patient (5%) had intact fibula as show below in table no. VI.

Table No. VI Showing Condition of Fibula :-

Condition of Fibula	No. of Cases	Percentage
Fractured fibula	19	95
Intact fibula	1	5
Total	20	100

Site :- Fractures of proximal 1/3rd were not included in our study. In our study majority of cases had fracture of junction of middle and distal 1/3rd (55%) followed by 40% cases of middle 1/3rd and one cases of segmental fracture as could be observed in underlying table no. VII.

Table No. VII Showing Level of Fracture :-

Level of Fracture	No. of Cases	Percentage
Proximal 1/3rd	-	
Middle 1/3rd	8	40
Junction of middle & distal 1/3rd	11	5
Segmental	1	5
Total	20	100

Fracture Pattern :- Out of 20 cases majority of patients (50%) under taken in this study had comminution followed by 5 cases (25%) of spiral fracture, 3 cases (15%) of short oblique and one each was log oblique and segmental fracture as shown below in table no. VIII.

Table No. VIII Showing & Fracture Pattern :-

Fracture Pattern	No. of Cases	Percentage
Comminuted #	10	50
Spiral #	5	25
Short-oblique	3	15
Long oblique	1	5
Segmental #	1	5
Total	20	100

Nature Of Fracture :- Extent of soft tissue damage was assessed on the basis of classification proposed by Gustilo et al (1984).

Out of the 20 cases 11 cases (55%) were closed, while nine cases (45%) were open type as depicted in table no. IX.

Table No. IX Showing Nature of Fracture

Nature of Fracture According to Soft Tissue Damage	No. of Cases	Percentage
Closed	11	55
Open (Gustilo et al)	9	45
(a)Grade I	7	35
(b) Grade II	2	10
(c) Grade III	-	-
Total	20	100

Associated Injuries :- Out of 20 patients 2 cases (10%) had fracture of medial malleolus, while 1 case each was associated with head injury, fracture shaft femur, fracture shaft humerous and fracture of lateral malleolus as shown below in table no. X.

Table X Showing Associated Injuries

SN	Associated Injuries	No. of Cases	Percentage
1.	Head Injury	1	5
2.	Fracture of Medial mallelous	2	10
3.	Fracture lateral mallelous	1	5
4.	Fracture shaft femur	1	5
5.	Fracture shaft humerous	1	5
	Total	6	30

Time Interval Between Injury And First Aid :

Among the 20 cases, 12 (60%) cases attended within 6 hours and remaining 8 (40%) cases were attended after 6 hours as depicted in table number XI.

Table No. XI Showing Time Interval Between Injury and First Aid:-

Time Interval (Hours)	Close		Open				Total	
			Grade I		Grade II			
	No	%	No	%	No	%	No	%
< 6 hours	6	54.55	5	71.43	1	50	12	60
> 6 hours	5	45.45	2	28.57	1	50	8	40
Total	11	100	7	100	2	100	20	100

Preoperative Period :-

Out of 20 patients in our series 11 cases were closed type and 9 cases were of open type.

Among the 11 closed fracture 5 cases were operate within 7 days while 4 cases in between 8-14 days and 2 cases were operated in the duration between 15-21 days as shown below in table number XII.

Out of 9 cases of open fractures 2 cases were operated within 7 days, 4 were operated between 8-14 days as shown below in table number XIII.

Table No. XII Showing preoperative period in closed fractures

Period	No. of Cases	Percentage
Less than 6 hours	-	-
Within 7 days	5	45.45
8-14 days	4	36.36
15-21 days	2	18.19
>21 days	-	-
Total	11	100

Table No. XIII Showing preoperative period in open fractures :-

Period	Grade I		Grade II		Total	
	No	%	No	%	No	%
Less than 6 hours	-	-	-	-	-	-
Within 7 days	2	28.57			2	22.22
8-14 days	4	57.15	-		4	44.44
15-21 days	1	14-28	2	100	3	33.33
> 21 days	-	-	-	-	-	-
Total	7	100	2	100	9	100

Type Of Locking :-

Out of 20 cases of our series in majority of cases (55%) distal interlocking was attempted. While in 8 (40%) cases static interlocking was done. In one (5%) of the patient static interlocking was attempted but screw was not in the distal hole and locking thus achieved was that of proximal dynamic as shown below in table number XIV.

Table XIV Showing Type of Locking

Type	No	Percentage
Static	8	40
Dynamic		
(a) Proximal	1	5
(b) Distal	11	55
Total	20	100

Postoperative Hospitalization :-

Out of 20 patients in 13 patients (65%) duration of post operative hospitalization was between 8-14 days. In the earlier case we were extra cautions about the follow up. Which increased the postoperative hospitalization of patients. Cases operated at a later date did not cooperated with the physiotherapy regime. Which increased their postoperative period.

Table XV Showing Duration of Post Operative Hospitalization

Duration (Days)	No. of Cases	Percentage
8-14	13	65
15-21	7	35
Total	20%	100

Duration Of Follow Up :- The length of follow up in our series varied from 3-12 months. 16 patients could be followed for 3-6 months. Whereas 2 patients has been followed up for 7-9 months. Where as remaining 2 patients has followed up for 10-12 months as shown below in table number XVI.

Table No.XVI Showing Duration of Follow-up

Follow up in Months	No. of Cases	Percentage
3-6	16	80%
7-9	2	10%
10-12	2	10%
Total	20	100

Weight Bearing :- Partial weight bearing was permitted as per pain tolerance of the patient except those patients where weight bearing was contraindicated due to associated injury if any.

13 patients (65%) started partial weight bearing on 2nd or 3rd postoperative day. Whereas remaining 7 cases (35%) did not cooperated for about 6 weeks postoperative period.

Full weight bearing was however not permitted till radiological union of fracture.

Active physiotherapy of knee, ankle and toe's were encouraged throughout the postoperative period.

Time Taken in Union

Union of fracture was considered when :-

1. Full weight bearing was painless.
2. Rotary / angulary strain painless.
3. Bridging callus present.

Fracture united in less than 5 month considered as normal union period. The patient's were assessed clinically and radiologicaly at one months interval. 10 of 11 closed fractures united well within 20 weeks. The remaining took 24 weeks to unite. Thus all the closed type of fracture united well within 24 weeks.

Out of 9 cases of compound fractures, 7 cases united well within 20 weeks. One case at 24 weeks and remaining did not united till the last month of follow up as could be observed in underlying table number XVI.

Table No. XVII Showing the time taken in Union

Period in Weeks	Closed		Open				Total	
			Grade I		Grade II			
	No	%	No	%	No	%	No	%
12-16	8	72.72	4	57.15			12	60
17-19	2	18.18	2	28.57	1	50	5	25
20-24	1	9.10	1	14.28			2	10
Un-united*	-	-	-	-	1	50	1	5
Total	11	100%	7	100	2	100%	20	100%

Not united till completion of this study after ten months of follow up.

Time taken in union of fracture in relation to type of fracture pattern :

Duration of union varied according to the fracture pattern. Out of 4 oblique fractures 3 were united within 20 weeks, rest 1 cases of short oblique which was of grade II compound not united till last of months of follow up. All the 5 cases (25%) of spiral fractures united well within 16 weeks and 10 cases (50%) of comminuted fracture out of which 9 cases were united well within 20 weeks rest 1 cases of comminuted fracture achieved union at 24 weeks. One case of segmental fracture was studied in this series and it had achieved union at 24 weeks as shown below in Table No. XVIII.

Table No. XVIII showing time taken in union of fracture in relation to type of fracture pattern

Period in week	Oblique Fracture		Spiral Fracture		Comminuted Fracture		Segmental Fracture		Total	
	No	%	No	%	No	%	No	%	No	%
12-16	2	50	5	100	5	50	-	-	12	60
17-19	1	25	-	-	4	40	-	-	5	25
20-24	-	-	-	-	1	10	1	100	2	10
Un-united	1	25	-	-	-	-	-		1	5
Total	4	100	5	100	10	100	1	100	20	100

Complications :-

In our series 1 case of grade IInd compound fracture not united till last month (10 month) of follow up, hence considered as non union and 1 case each develop delayed union in simple and grade I compound fractures, 1 cases got superficial infections, 1 case had deep infections, shortening of less than 1 cm in 2 patients was observed, 3 patients complained a pain round the knee joint as could be observed in table No. XIX.

Table XIX showing complications

Complications	No. of Cases	%
1. Superficial infection	1	5%
2. Deep infections	1	5%
Shortening <1 Cm	2	10%
4. Stiffness of ankle	3	15%
5. Delayed union*	2	10%
6. Non Union	1	5%
7. Knee pain	3	15%
8. Stiffness of knee joint	2	10%

Time taken in union more than 20 weeks.

Overall Functional Results :- For evaluation of the final functional results, we followed the criteria laid down by Reudy and all Gower (1984). Pain and range of movement at knee and ankle are seen and assessed after the fracture had united clinically and radiologically. 3 of our patient had persisting pain at knee and ankle rest 17 patients (85%) were absolutely pain free only two patients had terminal degree of restriction of movements. Rest 18 patients (90%) had full range of the active movement at the knee.

At ankle 17 (85%) patients had full range of painless movements. Where as 3 patient has some restriction of movements. Two of whom had restriction of terminal degree of 5-10% of dorsiflexion and 1 patient had restriction of more

then 10^0 of dorse – flexion. None of these patients had restriction of planter flexion movements as could be observed in underlying table number XX.

Table No. XX showing overall functional results

Criteria	No. of Cases	%
Pain at knee and ankle on walking	3	15
Movement of		
Knee Joint –Full	18	90
Restricted	2	10
Movement		
Ankle Joint – Full	17	85
Restricted $0\text{-}10^0$	2	10
– $10\text{-}20^0$	1	5

Final Evaluation Of Results :-

For final evaluation of patient the criteria laid down by Reudi and All Gower (1984) were observed and classified as very good, good, moderate and poor. In series of closed fractures treated by this method. 8 out of 11 (72.72%) had very good results and 2 patient (18.18%) had good results however one patient had delayed union and hence was considered as moderate result.

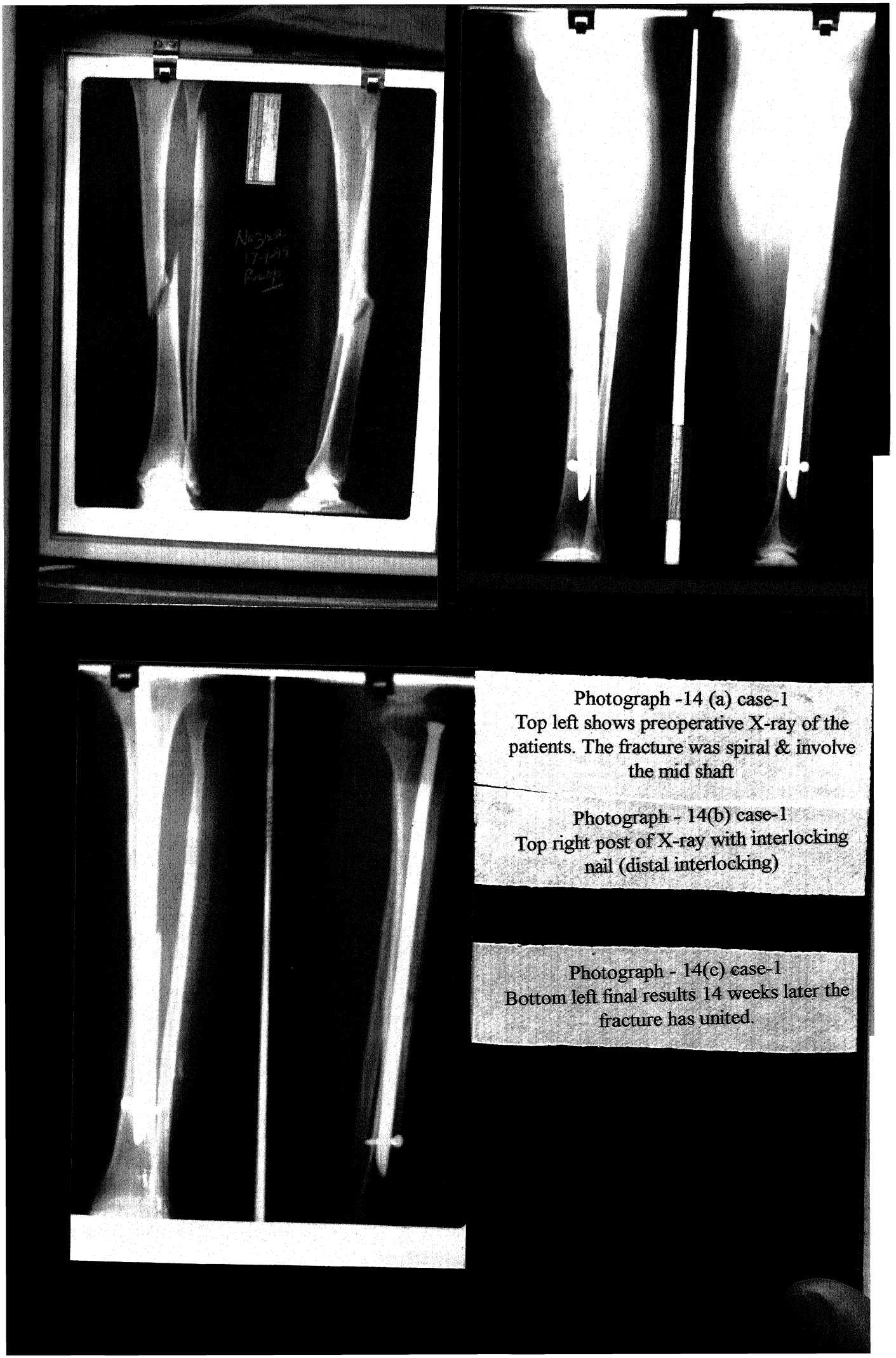
In similar series of compound fractures using same criteria 6 had very good result, one good result, however moderate and poor results were seen in one case each.

Combined both group 85% of patient has very good and good results where as non union was observed in a isolated case of grade II compound

fracture, 2 patient had delayed union. 1 from closed fracture series and one from open fractures series as shown below in table No. XXI.

Table No. XXI Showing Final Evaluation of Results

Type of Fracture	Very good		Good		Moderate		Poor		Total
	No	%	No	%	No	%	No	%	
Closed	8	72.73	2	18.18	1	9.09	-		11
Open									
(A) Grade I	5	71.4	1	14.28	1	14.28	-		7
(B) GradeII	1	50	-		-		1	50	2
Total	14		3		2		1		20
Over all %	70		15		10		5		100



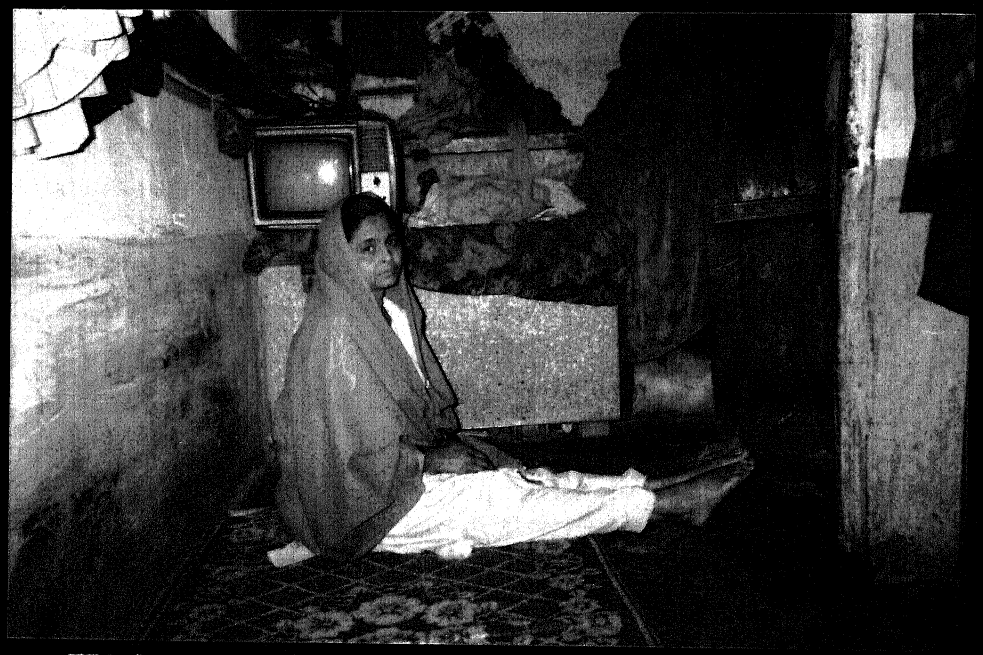
Photograph -14 (a) case-1
Top left shows preoperative X-ray of the patients. The fracture was spiral & involve the mid shaft

Photograph - 14(b) case-1
Top right post of X-ray with interlocking nail (distal interlocking)

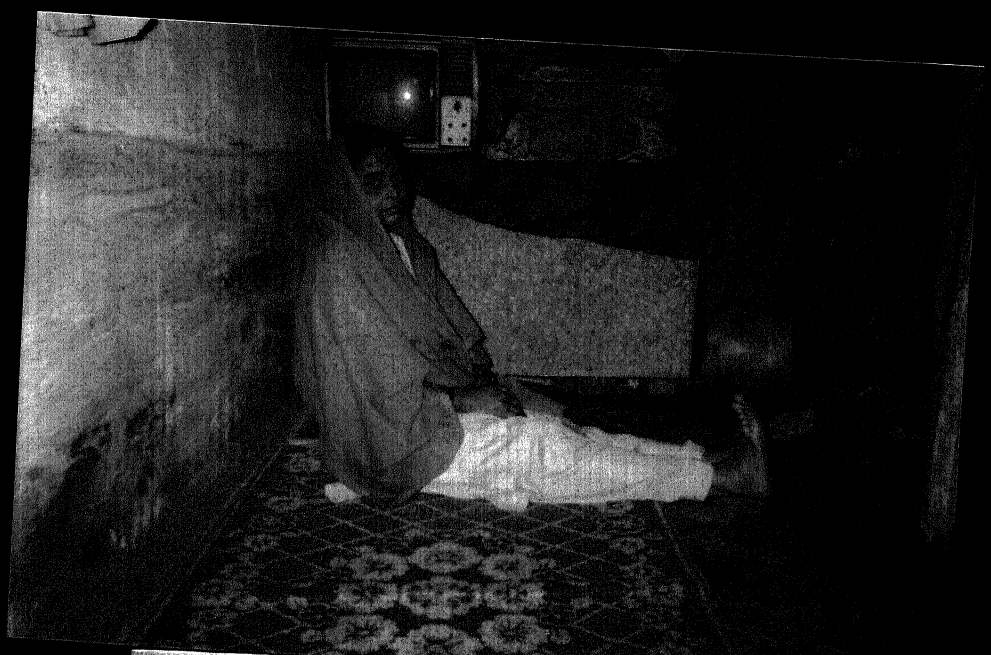
Photograph - 14(c) case-1
Bottom left final results 14 weeks later the fracture has united.

Photograph -14 (d) case-1
Left patients is seen 14 weeks post op. bearing full weight. After union of fracture.

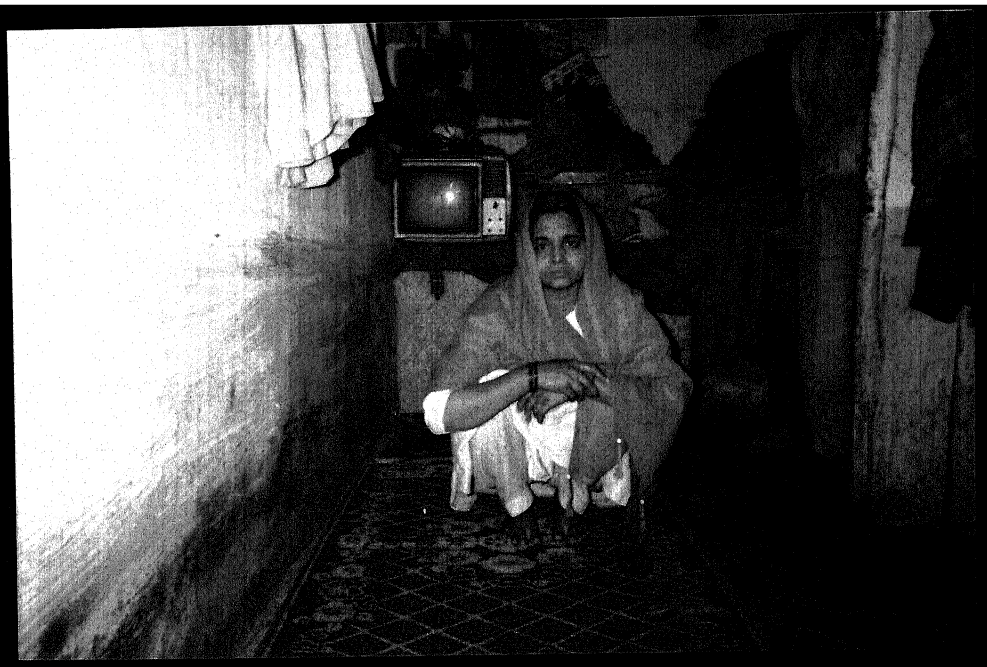
Photograph -14 (e) case-1
Right shows the patient bearing weight on the affected limb after 14 weeks.



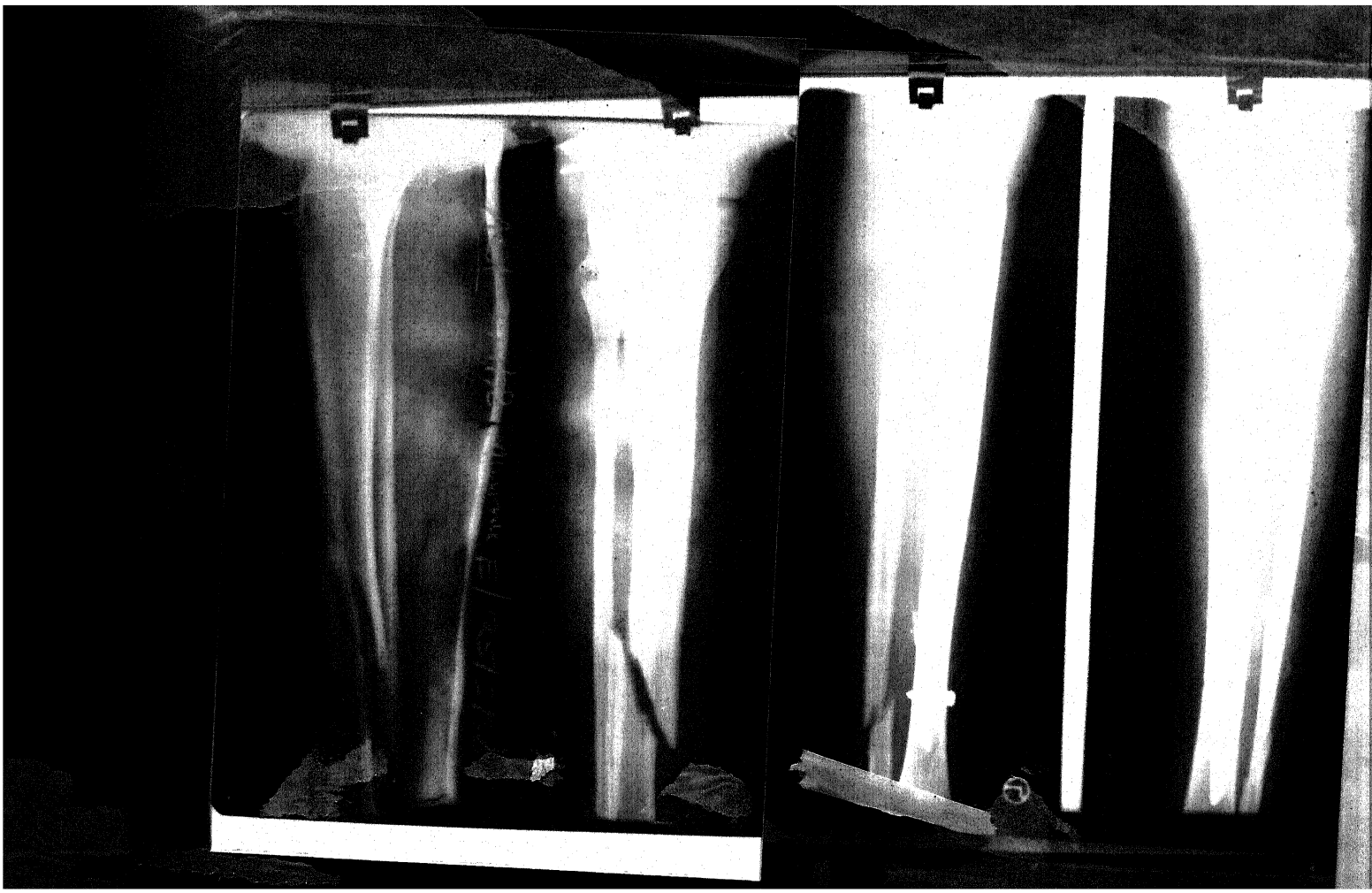
Photograph -14 (f)
Patient is seen planter flexing the foot, there is no limitation of movement.



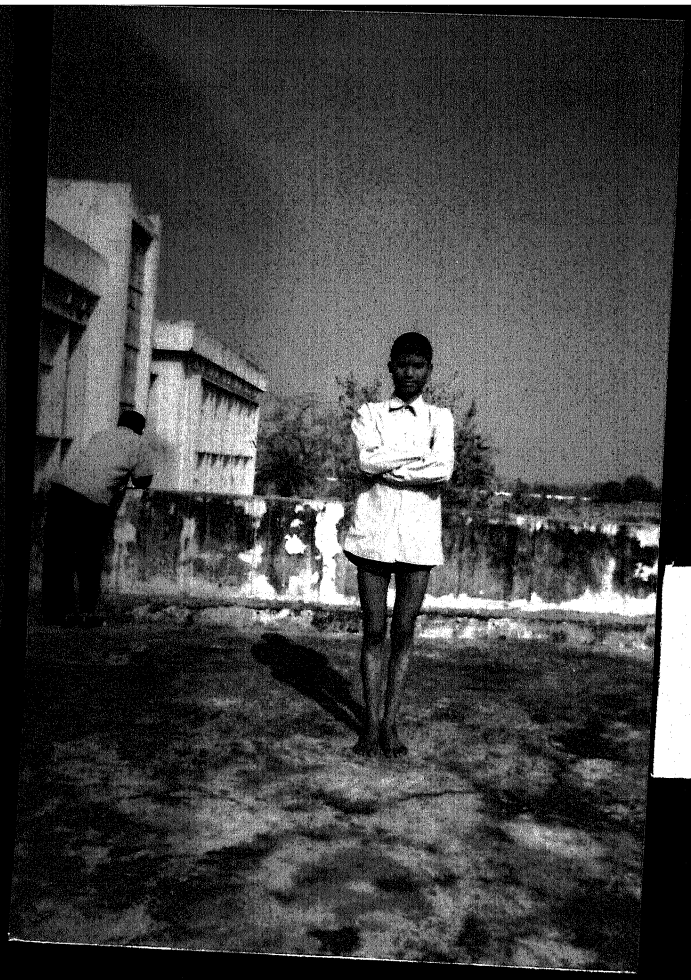
Photograph -14 (g)
Above the patients is seen dorsi flexon of the foot, there is no limitations of movements.



Photograph -14 h (above) & i (below)
Shows the patient is sqatting and cross legged position respectively, there is no restriction even these complex movement.



Photograph -15 (a) case-2
Top left (b) top right (c) bottom left shows the preoperative, post operative & final X-ray of case no. 2 respectively. Fracture was long oblique involving the junction at middle and distal one third. Fracture united at 15 weeks.

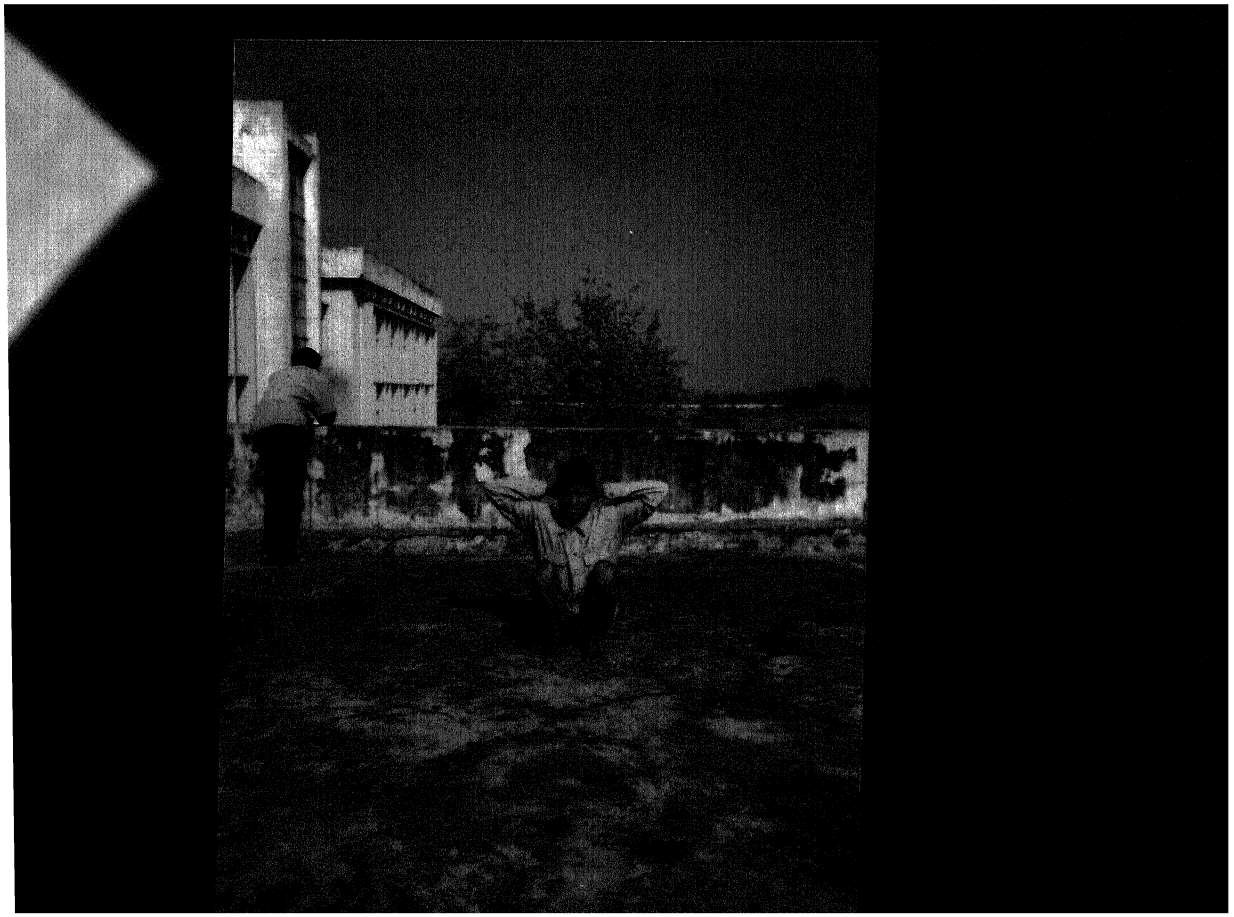


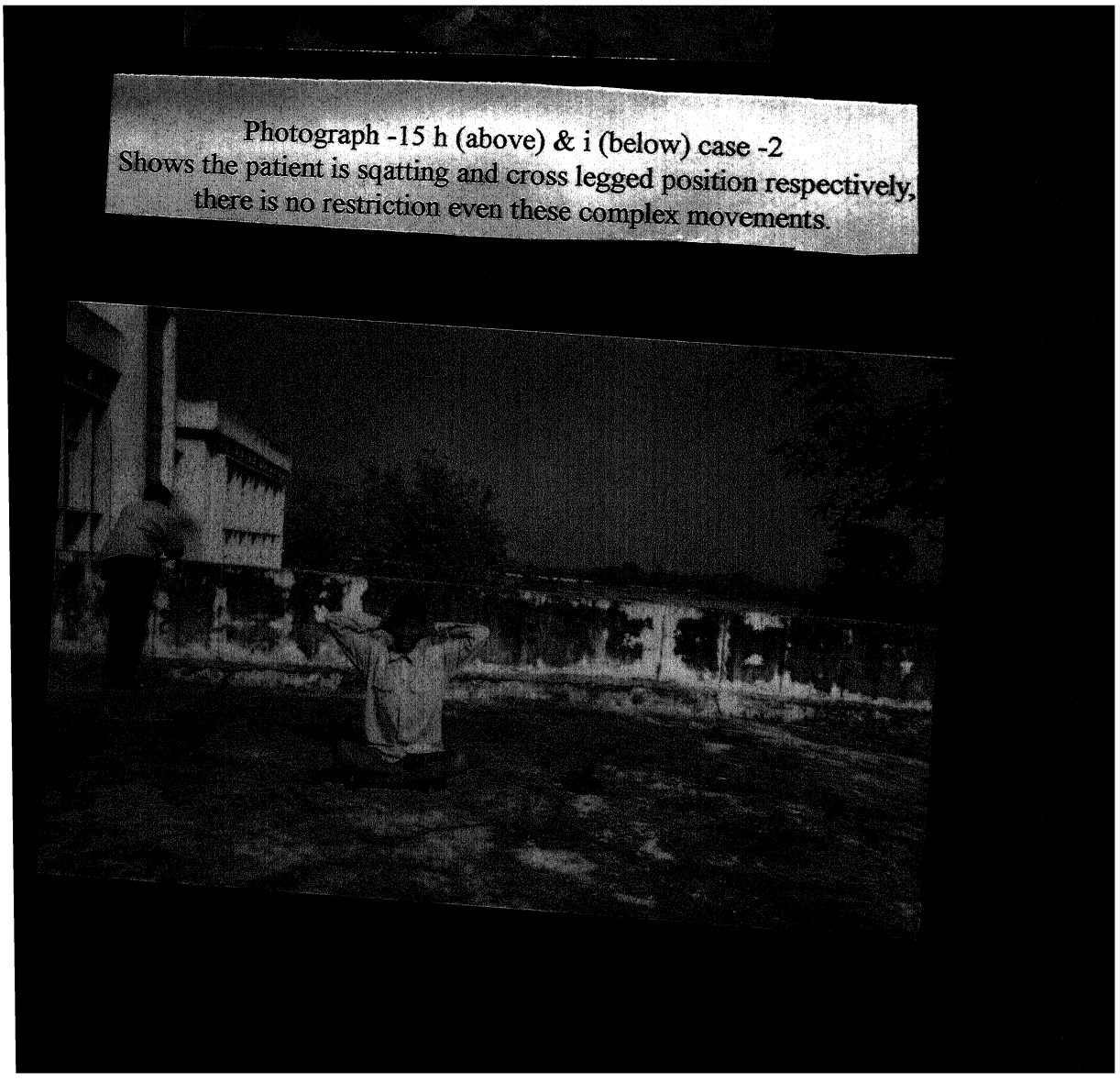
Photograph -15 d (Left) case-2
shows the patient bearing weight on the both limb after union 15 weeks later

Photograph -15 (e) (Right) case-2
Shows the patient bearing weight on the affected limb after 15 weeks.

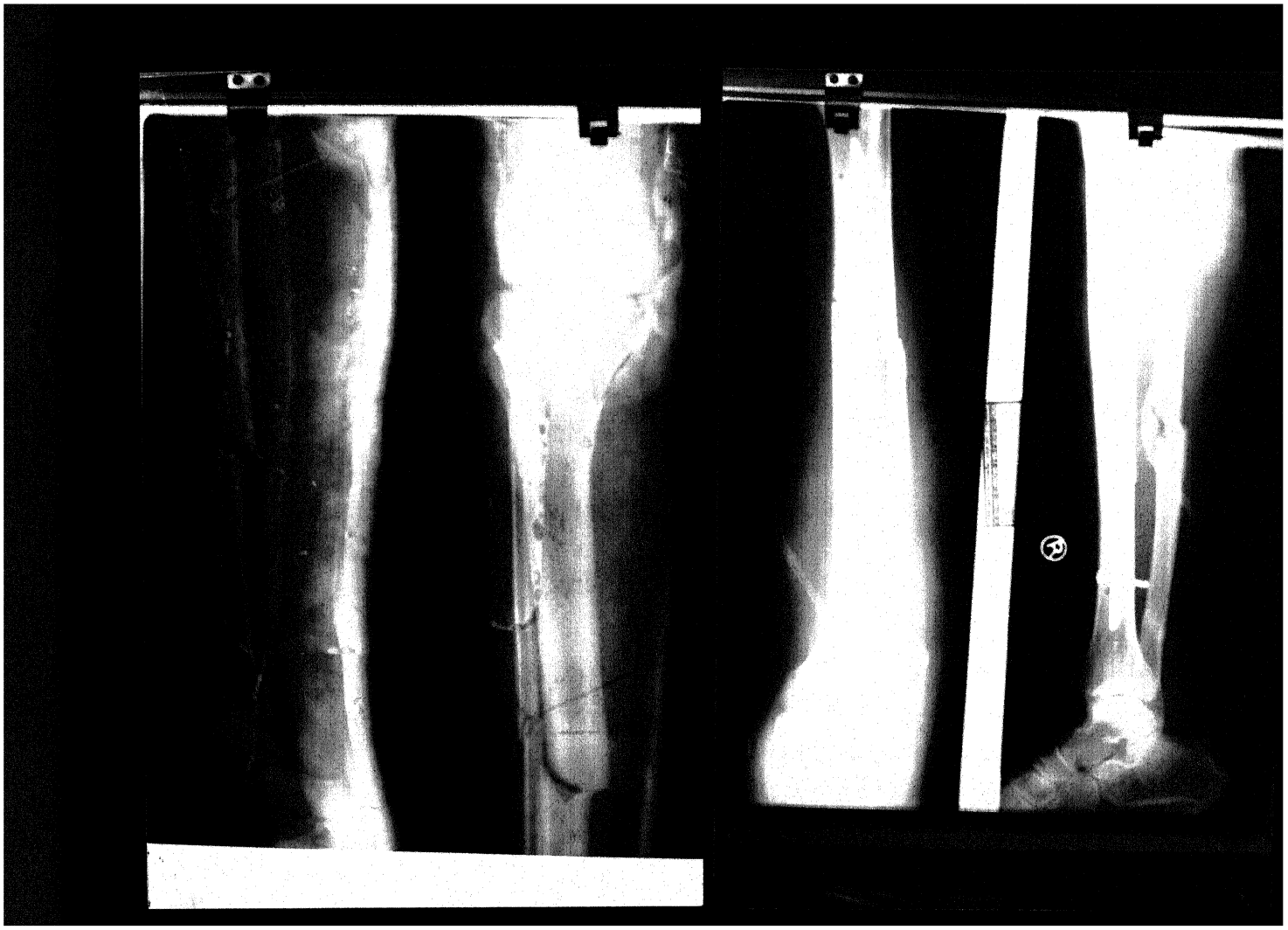
Photograph -15 f (Above) case -2
Patient is seen planter flexing the foot, there is no limitation of movement.

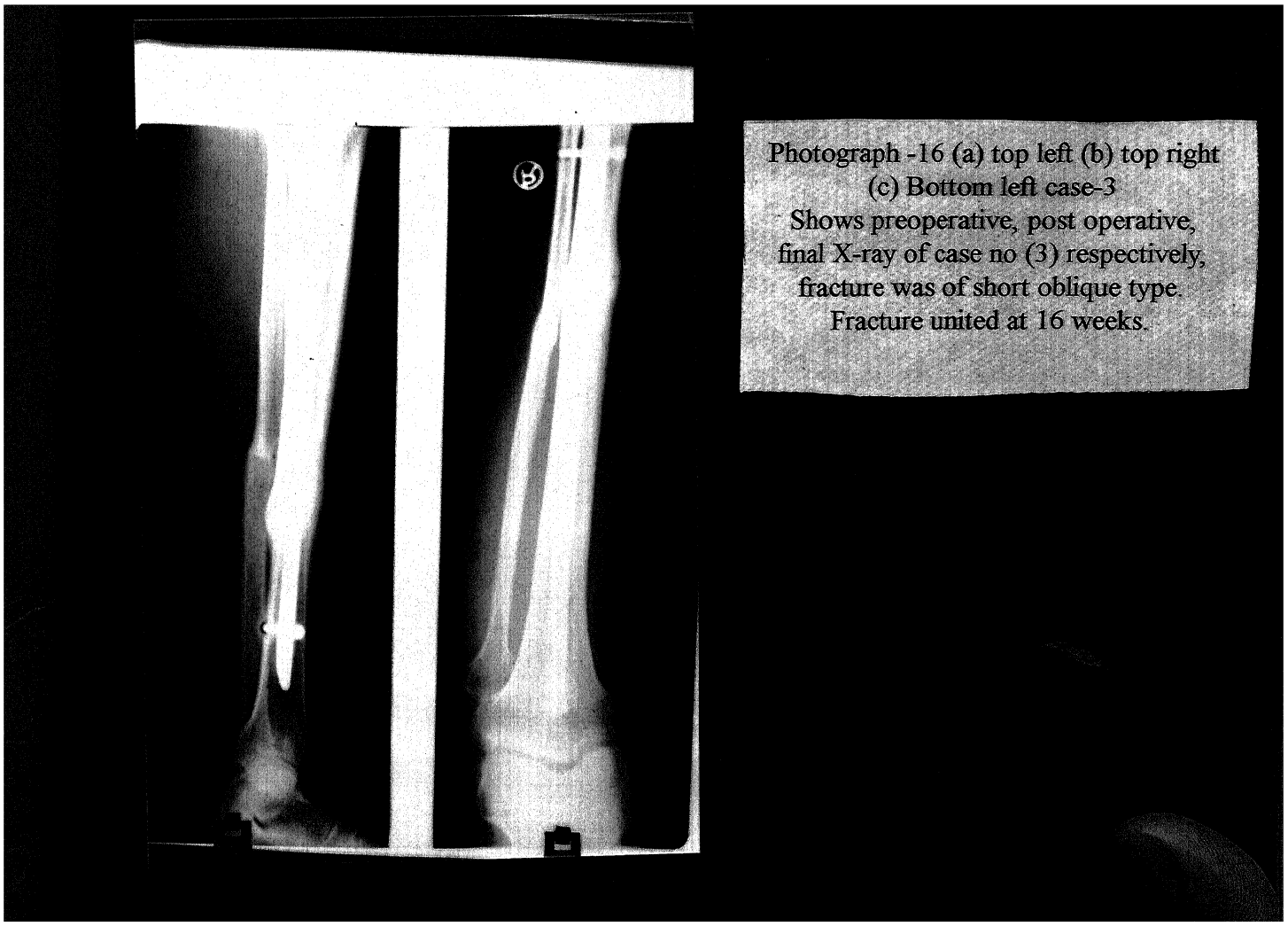
Photograph -15 g (Above) case -2
Shows the patients is seen dorsi flexon of the foot, there is no limitations of movements.



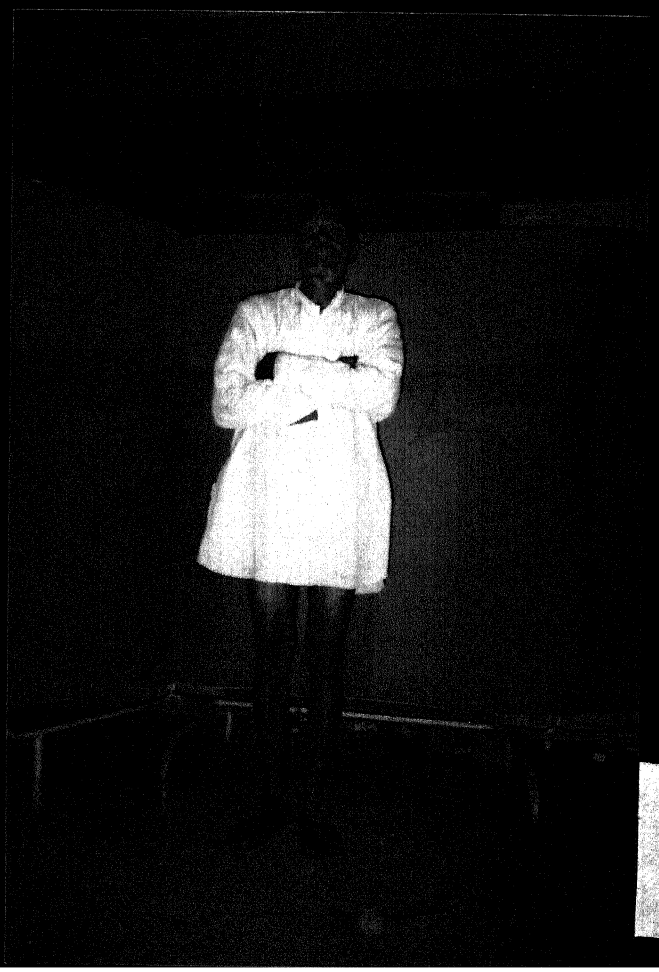


Photograph -15 h (above) & i (below) case -2
Shows the patient is sqatting and cross legged position respectively, there is no restriction even these complex movements.

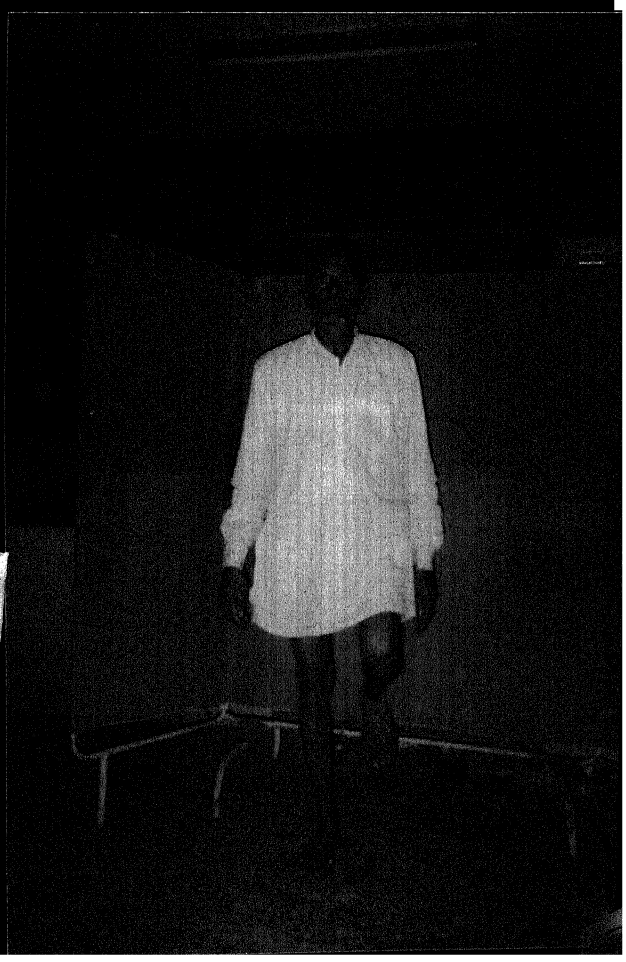




Photograph -16 (a) top left (b) top right
(c) Bottom left case-3
Shows preoperative, post operative,
final X-ray of case no (3) respectively,
fracture was of short oblique type.
Fracture united at 16 weeks.



Photograph -16 (d) case-3
Top left patients is seen 16 weeks post op. bearing full weight. After union of fracture.

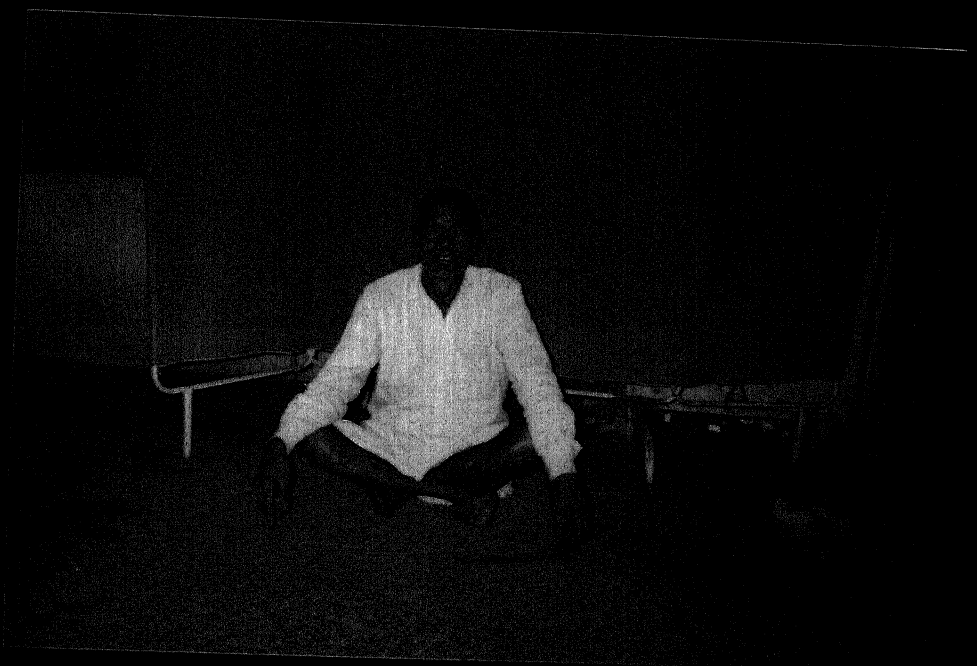


Photograph -16 (e) case-3
Right shows the patient bearing weight on the affected limb after 16 weeks.

Photograph -16 f (Above) case -3
Patient is seen planter flexing the foot, there is no limitation of movement.

Photograph -16 (g) case -3
Above the patients is seen dorsi flexon of the foot, there is no limitations of movements.

Photograph -16 h (above) & i (below) case -3
Shows the patient is sqatting and cross legged position respectively, there is no restriction even these complex movement.



Photograph -17 (a) case-15
Top left (b) top right (c) bottom left shows the preoperative, post operative & final X-ray of case no. 15 respectively.
Fracture was oblique communited involving the mid shaft.
Fracture united at 15 weeks.

Photograph -17 d (Left) case-15
shows the patient bearing weight on the
both limb after union 15 weeks later

Photograph -17 (e) (Right) case-15
Shows the patient bearing weight on the
affected limb after 15 weeks.

Photograph -17 f (Above) case -15
Patient is seen planter flexing the foot, there is no limitation of movement.

Photograph -17 (g) case -15
Above the patients is seen dorsi flexon of the foot, there is no limitations of movements.

Photograph -17 case -16 (Above)
Shows patients is sitting comfortably

Discussion

DISCUSSION

The management of unstable tibial shaft fractures always-challenging problem to orthopaedic surgeon.

As the bone underlying direct under the skin and has no muscular attachment on its medical surface, with poor vascularity in distalized 1/3rd thus healing occurs at slow pase. The bone takes a major part of weight bearing and unstability leads to stress at the fracture site resulting in delayed and non-union.

To over come these problems and to retain length near anatomical alignment and provide a favourable milleu interior for fracture healing.

The worker suggested early fixation by reamed or unreamed interlocking tibial nails. Interlocking fixation could be both dynamic or static.

Dynamic locking controls bending and rotational stress retaining the possibilities of axial loading thus compression osteogenesis occurs.

Static locking however preserves control by bone bending and rotational stress and permits full axial load transfer from bone to bone but does not permits axial compression. Thus higher incidence of delayed union and non-union. Thus demands dynamization in some cases.

Interlocking nail as described by A.O.'s is technically demanding needs a costly inventory of instruments, implants such as image intensifier, flexible reamer, power drill etc. Which is beyond the affordability of govt. setups or majority of private sectors enterprises facing severe financial constraints.

A simple interlocking 'D' nail devised by Dr. K.P. Daga retain the advantage of interlocking nail but do not necessiate the costly. Inventory of instruments and implants. Does not necessiate the use of image intensifier, can be done under ordinary mobile Xray control.

So the present study is based on the study of 20 patients of unstable tibial shaft fractures treated by 'D' interlocking tibial nail of Dr. Daga.

Most of our patients (60%) were young adult 19-40 years of age. (Average age being 37.3 years). This is due to the established facts that patients in this age are most active and have brunt of social responsibilities and hence more expense to trauma including the road traffic accidents. Similar observation of higher incidence of this fracture in young adults, average age of around 35 years has also been reported by Eklend et al (1984) and C.M. Court Brown et al (1990).

Males predominated over females the incidence of these fractures. This is again due to more involvement of males in outdoor activities and heavy work as compared to females. Similar observations have also been described by workers such as Paul Tornetta III et al series of 1994.

Nature of occupation has no correlation with the fracture as reported by various workers. However in our series labourer and farmers out numbered then all other group.

The injury is caused by road traffic accidents, fall of heavy weight over limb, fall from height, collapse of a roof or a wall, slipping on the floor etc. The most common most of injuries (75%) being road traffic accidents. Our these observations are in accordance with observation made by A Paige Whittle et al (1992). Who reported 78% of these fractures due to road traffic accidents.

Right leg was more commonly involved as compared to left ratio being 13 stood 7 that is the involvement of right leg is roughly twice more common then the left. The preponderance of right leg of this injury is not reported by any author. It could be due to dominance of the right side of the body over left.

With the increasing high speed vehicle the high speed vehicle. The high speed trauma is increasing resulting in higher incidence of comminuted fractures. 50% of our fractures were comminuted, 25% spiral #, 20% oblique and 5% segmental #.

The figure varied considerably wit different authors. Ekelend et al (1982) series transverse or short oblique fracture were 42%, long oblique fracture 27% comminuted 20% and segmental 11%.

More than half of our cases had fracture at the Junction of middle and distal 1/3rd or distal 1/3^{r} , middle 1/3rd was involved in 40% cases. Whereas 5% cases has segmental fractures. Similar observations of higher incidence of 51.2% were in distal 1/3rd of tibia has been made by court brown et al (1990).

Poly trauma is fast increasing with increasing modernization and become across more and more cases of poly trauma in our day to day practice. 30% of our cases were the cases of poly trauma. However the incidence of polytrauma in still higher in developed country and similar study a Paige Whittle et al (1982) reported 68% cases having associated musculo skeletal injury.

The time lapse between injury and treatment varied considerably from patient to patient, from series to series. Higher the time lapse in the risk of complications both local and systemic as unsupported loose fragments of bone further damage the surrounding tissues, jeoparadise the vascularity of local region including skin adding to the risk of infection, delayed union, non-union.

The proper first aid at the site of accident, a good transportation to the hospital and early definite treatment have their own importance in the final outcome of the results.

This is the established fact that a compound fractures operated within 6 hours of injury or after it have a definite difference in rate of infection.

40% of our cases were treated by static locking, whereas 60% by dynamic interlocking. Among the dynamic locking we usually locked the distal hole as the fracture was the middle or distal 3rd. However in one cases of middle 1/3rd comminuted fracture distal locking fail and hence, was a case of forced proximal dynamic nailing.

Gross kemf & Weinsten recommends dynamic nailing in all transverse, short oblique fractures. He recommends static interlocking in comminuted or long spiral fracture or fractures with bone loss.

Period of hospitalization varied 10-22 days with an average hospital stay of 15-25 days. 65% were discharged within 2 weeks of operation and 35% were discharged within 3 weeks of operation.

In our series average follow up was 7.1 months and varied from 3-12 months. In a series of 21 cases Paul tronetta et al (1994) follow up varied from 19-36 months with a mean of 21 months.

However the period of follow up does not effect the evaluation of results of this procedure.

In our series the average union time has been 16.31±3.07 weeks. The ranging from 12-24 weeks. Closed fractures took lesser time to unite. The average union time in closed fracture was 15.63±3.10 weeks as compared to compound fractures average being 17.25±2.96 weeks. Slow healing in compound fractures is a well established fact and has been reported by various workers such as Paige Whittle, Reudi and all Gower, Ekeland, Donald and Saligson in his series. Which can be attributed to associated soft tissue injury. The increased union time and higher incidence of complications in compound fractures has been reported by various workers such as Court Brown, Weis and Stetsen etc.

While C.M. Court Brown et. al. in his study of 125 patients both closed and opened tibia fracture mean time of union was 16.7 weeks.

The increase union time and complication rate is directly proportional to the severity of compounding.

Donald and Saligson (1983) found average time for healing in closed fractures as 13 weeks, while Ekeland et. al. (1984) observed average healing time 16 weeks in compound fractures.

However, Oskar Linden and Funstien in their separate studies reported higher time 22.3 weeks and 30.4 weeks for union in healing of these fractures by conservative treatments. Which is definitely more than any method, conservative or operative today.

Healing time also varied according to the fracture pattern and we observed that the spiral fractures were earliest to heal, whereas comminuted and oblique fractures took maximum duration to heal.

In our series 4 were the case of oblique type fractures, 3 of whom took about 20 weeks to heal and the one case of short oblique fractures, which also had grade II compounding ended in non union (10 months of follow up).

The majority of spiral fractures united within 16 weeks. Comminuted fractures however behave similar to short oblique fracture in terms of union. A single case of segmental fracture achieved union at 24 weeks.

Muller, Nazarian and Koch found that torsional fractures with or without comminution have a better prognosis then high energy pattern such as short oblique with or without comminution.

Oni, Stafford, Gregg showed experimentally that torsional fracture tend to create a longitudinal tear of periosteum and may not disrupt the endosteal vessels, whereas short oblique or transverse fractures usually tears the periosteum circumfrentially and completely disrupt the endosteal circulation.

Complications of this method of treatment and fractures of both bone leg, whether simple or compound are non union one case, delayed union two cases superficial and deep infection one case each, stiffness of ankle 3 cases (15%) and of knee joint 2 cases (10%). One case of grade II compound with short obliquity ended in non union (10 months of follow up) and had to be treated by phemister bone grafting later on.

Paul Tronetta III et. al. in his series of 25 cases by interlock nailing reported 13.6% non union rate. Similar observations are also made by other workers.

Lower rate of non union in our series could be due to inherited dynamization of the nail.

Two of our case had delayed union. One of whom was a closed fracture, other was a case of grade I compound fracture. These two cases took 24 weeks each to unite.

Smith on his study of 219 cases treated by open reduction and internal fixation. Smith found delayed union in 48% cases.

The vast difference in less incidence of delayed union in our series could be due to inherent dynamic interlocking nail and early weight bearing.

Two of our cases had infection superficial and deep infection in one case each. Both were the grade I and grade II compound initially. The case of superficial infection heal well within 24 weeks and infection could be overcome by systemic antibiotic therapy.

The other case of grade II compound infection persisted and fracture has not healed (non union). Even dynamisation did not help.

Gustilo, Markin and Templeman (1990) reported infection rate 7.2% in their series, whereas Smith in his study of 219 cases of tibial fractures treated by open reduction and internal fixation reported infection in 20% of his cases.

Burnwell (1971) reported that 189 fractures of tibia treated by open reduction and internal fixation using burn and venable plate had a non union rate of 4.4%, infection rate of 6.6%. Barkin and Marshal (1971) fixed 3 sided plates in 92 tibial fractures which resulted 6 infection and 11 cases delayed union in his study.

Internal fixation with this method had no limb length discrepency. Only two cases (10%) of comminuted fractures had minimal shortening of less than 1 cm. and which was insignificant.

Similar observations has also been reported by Hess et. al. (1992). Who reported less than 1cm. shortening in 10% of his cases in a series of 125 cases.

Brown and Urban, however, observed higher incidence of shortening 27% less than 1cm., whereas 16% cases had more than 1cm.

However, conservative treatment leads to higher incidence of shortening as been reported by Weisman and Harold (1966) and Nicoll (1964).

Active use of limb was allowed as soon as the pain tolerance of the patients usually on 2^{nd} or 3^{rd} post operative day. Hence majority 85% of our patients have full range of movement at the knee and ankle joints.

3 (15%) of our patient, who did not cooperate in exercise programme have some stiffness of knee or ankle or both.

2 cases (10%) had 10° of extension lag. Similar observation of extension lag of more than 10^{0} have been reported while Ekeland et. al. more than 6.4% in his series.

3 cases (15%) had minimal stiffness of the ankle joint in our series while in Reudi et. al. (1972) in his series restriction of ankle movement between 5 to 15^{0} was in 11% cases.

Joseph (1974) reported frequent possibility of stiffness of knee and ankle joints with above knee pop cast.

The incidence of stiffness of ankle and knee joint much less by this method of treatment as compared to conservative treatments as has been reported by Joseph (1974), who found frequent possibility of knee and ankle stiffness with above knee pop cast.

Emerson and Grabie (1983) followed 183 tibial fractures immobilized with bilateral frames and found that more frequent complaint was ankle and knee stiffness.

Three (15%) of our cases complaint of knee pain, it was associated with kneeling. This was probably due to implant bursitis. When little more nail was left protruding the window in the bone. But incidence of knee pain in our series was much less as compared to as incidence of similar problem by C.M. Court Brown

series (1990), who reported that 40.8% of his cases had knee pain. This appreciable difference in lower incidence of knee pain in our series could be due to correct site of insertion or modification of nail.

Other complications like chest infections, pulmonary embolism, fat embolism, deep vein thrombosis were not observed in our series. The absence of these complications can be said to be because of early mobilization. Which was possible due to stable fixation.

We encouraged our patients to weight bearing on 2^{nd} or 3^{rd} post operative day. Majority of our patients walk with walker on 2^{nd} post operative day, however, 7 cases did not cooperate 4-6 weeks but did well after that when local pain disappeared.

Full weight bearing was, however, permitted after clinical and radiological evidence of union. Thus the majority of our patient did unsupported weight bearing till 12-24 weeks period. Court Brown et. al. (1990) series of 125 cases full weight bearing was started from 5-30 weeks periods post operative.

The results was evaluated according to criteria proposed by Reudi and All Gower (1976) and were classified as very good, good, moderate and poor.

72.73% of our cases of closed fractures had completed recovery of anatomy and functions and were labeled as very good results, whereas only 66.67% of the cases with compound fractures could be labeled as very good results.

On similar study by Reudi et. al. (1992) reported very good result in 77% cases in closed fractures and 43% of compound fractures.

18.18% of our cases of closed fractures had this criteria of minor problems such as tendency to swelling after exercise and loss of movement of knee and ankle joint of $5\text{-}15^{0}$, superficial infection. And hence were graded as good results, whereas 11.11% of the cases of compound fractures could be grades as good results in our series.

Reudi et. al. 21% and 41% in good results in closed and compound fractures respectively.

One case 11.11% of our study of grade II compound fracture of non union and deep infections hence labeled as poor results.

Reudi et. al. (1982) in his series of 219 cases had 4 poor results in his series as could be observed in underlying given below table :

Closed Fractures :

Results	Reudi et. al. Series (1982)	Our Series
Very Good	77%	72.73%
Good	21%	18.18%
Moderate	2%	9.09%
Poor	-	-
Total	100%	100%

Open Fractures :

Results	Reudi et. al. Series (1982)	Our Series
Very Good	43%	66.67%
Good	45%	11.11%
Moderate	10%	11.11%
Poor	4%	11.11
Total	100%	100%

Conclusions

CONCLUSION

20 cases of tibial shaft fractures both open and closed were treated by interlock intramedullary nail and the following conclusion was drawn :-

1. This is very simple, good method of internal fixation does not need any costly set of instruments. The use of image intensifier is not mandatory.
2. Closed or limited exposure technique preserves fracture haematoma. Their healing is faster with minimal complication and restoration of anatomy to near normal.
3. The average union time is 16.31 weeks, which is almost same in simple and compound fractures.
4. The method permits early weight bearing retains mobility at adjacent joint near ankle.
5. The complications are few and negligible.

Thus, this method of treatment retains all the advantages of conservative treatment and does not have the disadvantage of conservative treatment such as stiffness decreases. Thus, this method provides promising results.

Summary

SUMMARY

With increasing speed of life, severity and complexities of trauma are also increasing and tibia is among the most affected bone of the body.

Management of unstable tibial shaft fracture continues to be a challenge to a orthopaedic surgeons. With conventional treatment results are unsatisfactory and rate of complications in unacceptably high. This had lead to pendulum to swing towards operative mode of treatment among operative mode of treatment, the result of plating are not entirely satisfactory. Intramedullary nailing with interlocking by providing axial, angulatory and rotatory stability without Jeoparadising the vascularity of fracture fragments providing better environment for healing of bone and soft tissue (Ekeland et al 1982).

However because of demanding operative procedure and technical difficulties not many sergeons have attempted it. This study has simplified and modified the technique of original itnerlocking with following aims:-

1. The carry out, the procedure of intramedullary interlock nailing without the use of image intensifier and costly instruments and implants.
2. To study the results of interlocking nail in unstable fracture of tibial shaft (i.e. oblique spiral, comminuted and segmental).
3. To study the result of interlock nailing in open and closed fractures.

In our study 20 cases of tibial shaft fractures both open and closed were treated by interlocking nail and results were evaluated according to the criteria proposed by Reudi and All Gower (1976).

Out of 20 patients 11 closed and 9 cases were compound fractures (7 cases of Grade I and 2 cases of Grade II). Junction of middle and distal 1/3rd or distal 1/3rd was most commonly involved (55%) cases. 30 cases had one or more associated injuries.

These cases were subjected to full clinical and radiological examinations. The radiological was done by taking Xray full length with ankle and knee joint in both AP and lateral view and whole operation done without the use of image intensifier.

In sour series dynamic distal locking was done in 55% cases while proximal in 5% cases. Static locking was done in 40% cases. In one of patient in whom static locking was attempted the locking screw was not in the distal hole and the locking thus achieved was that of proximal dynamic type. The [illegible] was thus 5% in our series.

In our series partial weight bearing was permitted as per pain tolerance of the patient except those where weight bearing was contra indicated due to associated injury if any.

13 patients (65%) started partial weight bearing on 2nd or 3rd post operative day where as remaining 7 case (35%) did not cooperated for about 6 week, post operative period.

Full weight bearing was however started only after clinical and radiological evidence of union.

Active physiotherapy of ankle and knee and toe's was encouraged throughout the entire post operative period. Duration of follow up ranged from 3-12 months.

Shortening of less than 1 cm in 2 patients, superficial and deep infection one case each, stiffness of ankle joint in 3 cases (15%) knee joint in 2 cases (10%), delayed union occurs in 2 patients (10%) and 5 cases pass into non union.

Out of 20 patients, 18 patients (90%) full range of active movements, while 2 patients had restriction of movement at knee. At ankle 17 patients (85%) have full range of painless movements, where as 3 patients had some restriction of movements.

Average union time in this study has been 16.31 weeks. In closed fractures average duration union was 15.63 weeks. While in open fractures it was 17.25 weeks.

The results were evaluated according to criteria (Reudi and All Gower 1976).

Combined both group closed and open 85% of the patients had very good and good results. While in one cases of grade II compounding has poor result (non union).

By this study we concluded that :-

1. This is very simple, good method of internal fixation, does not need any costly set of instruments and implants, the use of image of intensifier is not mandatory.

2. Closed or limited exposure technique preserves fracture haematoma. Their healing is faster with minimal complications and restoration of anatomy to near normal.

3. The average union time is 16.31 weeks which is almost. Same in simple and compound fractures.

4. The method permits early weight bearing retains mobility at adjacent joint near ankle.

5. The complications are few and negligible.

Thus, this method of treatment retain, all the advantage of conservative treatment and does not have the disadvantage of conservative treatment such as stiffness decreases. Thus, this method provides promising results.

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